CITADIS EVOLUTION
TRACTION SYSTEM TROUBLESHOOTING MANUAL
TRACTION SyTM

CONTROLLATO DA / *CHECKED BY*	APPROVATO DA / *APPROVED BY*	DATA DATE
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AGGIORNAMENTI / *UPDATE*

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ALLEGATI / *ANNEX*

N. Documento ***Document Nr.***	**Descrizione** ***Description***

INDICE / *INDEX*

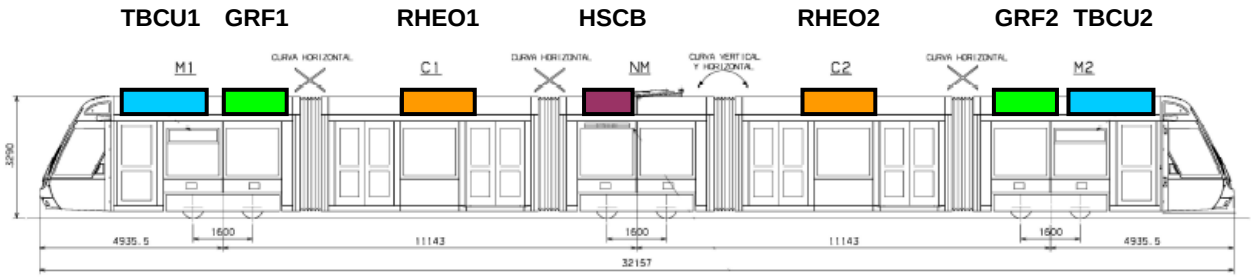
1. Introduction

1.1. Scope

Scope of this document is to support troubleshooting activities for the Traction System **CITADIS EVOLUTION.** This guide, based on diagnostic events recorded on the Agate3mini control electronic, describes operations to identify the broken LRU. The related replacement procedures are described in the Maintenance Manual.

1.2. Perimeter

The role of the Traction System is to control and monitor one motorized bogie, and the related devices (mechanical brake unit, motor cooling system GRF).
The context of the Traction System is the new CITADIS EVOLUTION platform, a family of vehicles based on a modular architecture able to fulfill different requirements using a standardized set of subsystems. Following the same philosophy, the traction box is part of these 'module library' and will be used across a wide range of tram composition (ie vehicle with two or three motorized bogie, different gear ratio and wheel diameters, AS or PM motors type …) by a simple SW configuration.



Example of CITADIS EVOLUTION 302 type vehicle with 2 motorized bogie.

1.3. References

[R1]	Citadis Evolution Traction SyUM	145UT – AY39405
[R2]	Citadis X02 – MAS 1AC3 detailed LV scheme	AY32185
[R3]	Citadis X04 – PMM 1AC3 detailed LV scheme	AY30287
[R4]	Citadis Evolution – TSP TROUBLE SHOOTING GUIDE	TRV1306LB17228-3

1.4. Terminology and Acronyms

DSP	: **D**igital **S**ignal **P**rocessor
IGBT	: **I**nsulated **G**ate **B**ipolar **T**ransistor
IO	: **I**nput / **O**utput
LV	: **L**ow **V**oltage
MAS	: Asynchronous motor
PMM	: **P**ermanent **M**agnet **M**otor
TCMS	: **T**rain **C**ontrol and **M**onitoring **S**ystem
BCU	: Mechanical **B**raking **C**ontrol **U**nit
MVB	: **M**ultifunction **V**ehicle **B**us
DC	: **D**irect (continuous) **C**urrent
HV	: **H**igh **V**oltage
APS	: Ground power supply
GRF	: Motor Cooling Unit
HW, SW	: **H**ard**w**are, **S**oft**w**are
NC	: **N**ormally **C**lose contact
NO	: **N**ormally **O**pen contact
HSCB	: **H**igh **S**peed **C**ircuit **B**reaker

2. General characteristics

2.1. Product Presentation

The main characteristics of the CITADIS EVOLUTION Traction basic unit are :

- 850DLP3 power module (low power IGBT inverter)
- AGATE3mini electronic control unit, able to control 2 AS or PM motors
- Interface with Train Control System (TCMS) via MVB network and LV logic train lines
- Control SW design process meets SSIL2 safety requirements

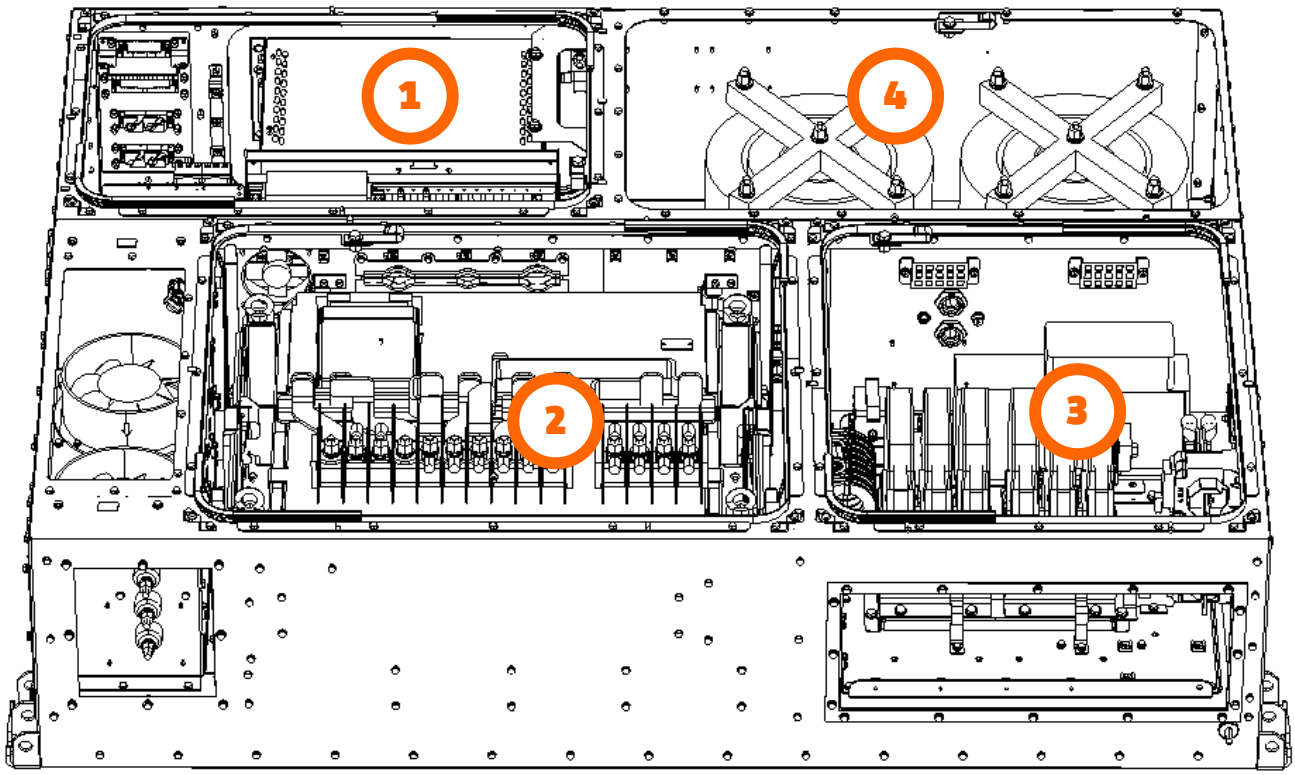
Different product versions are available :

1. 850-R-STD/MAS/DLP/1AC3 : standard architecture, two asynchronous motors
2. 850-R-STD/PMM/DLP/1AC3 : standard architecture, two permanent magnet motors

Each version shares the same functional interface (LV train lines and MVB message structure) in order to minimize modification at train level.

2.2. Traction Converter Mechanical Layout

Here below a top-view of the Citadis Traction cubicle, useful to understand the main subsystems location and physical position of the electrical connectors.
All the different product versions share the same mechanical layout; LV connectors are located close to the Agate rack compartment (right-bottom corner on the drawing below).

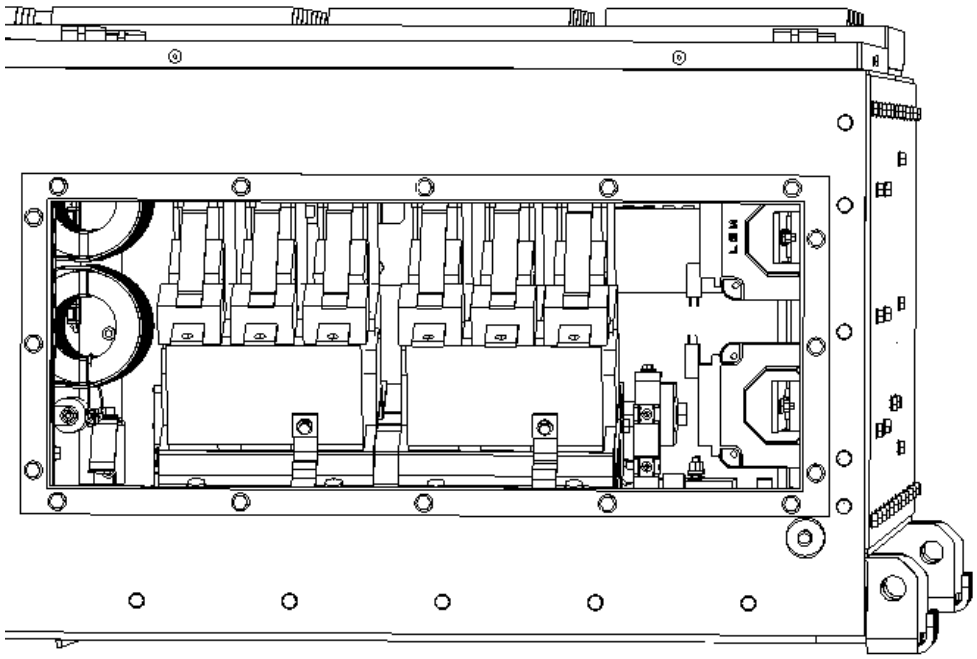


POS	Description
1	Agate rack and LV compartment
2	power module
3	high voltage devices
4	inductances compartment

2.3. HV Overview

2.3.1. Electrical connectors

2.3.1.1. HV inputs and Motor outputs

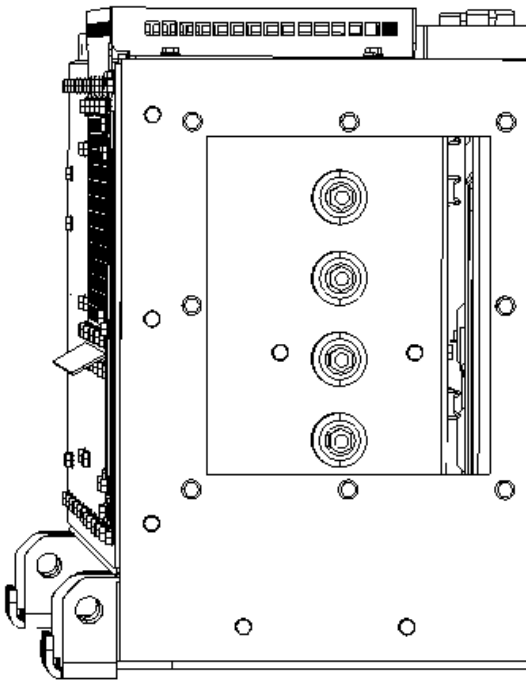


HV Pos
From HSCB

HV Neg
To ground

U2 V2 W2 U1 V1 W1 To motors

2.3.1.2. Braking Resistors outputs



RH1 pos
To braking chopper 1

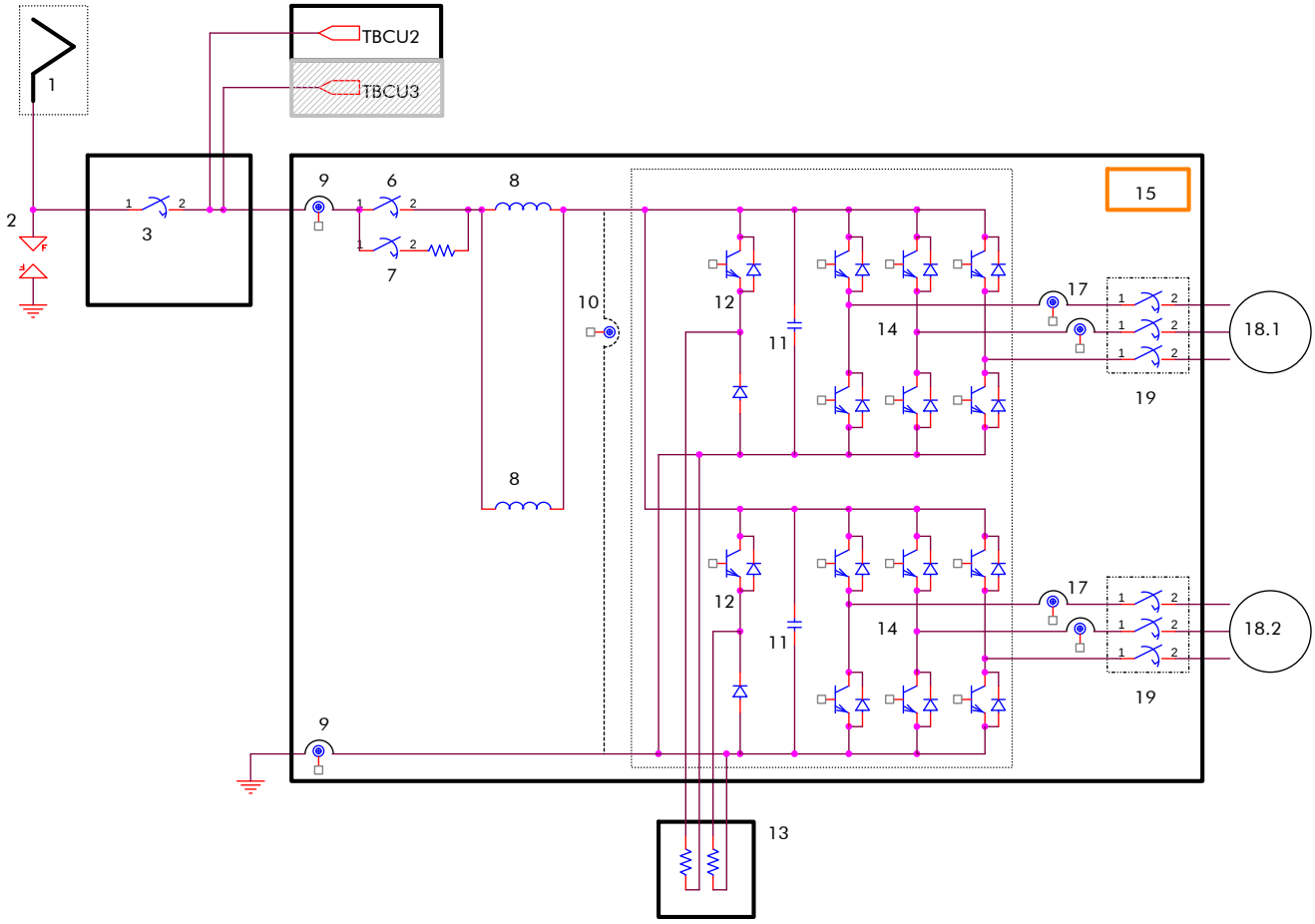
RH1 neg
To braking chopper 1

RH2 pos
To braking chopper 2

RH2 neg
To braking chopper 2

2.3.2. HV Scheme - Standard Configuration

Here below the principle high voltage scheme of the Citadis traction converter in standard configuration (single Agate control). The ONIX850DLP3 power module is configured to have a single input precharge circuit.



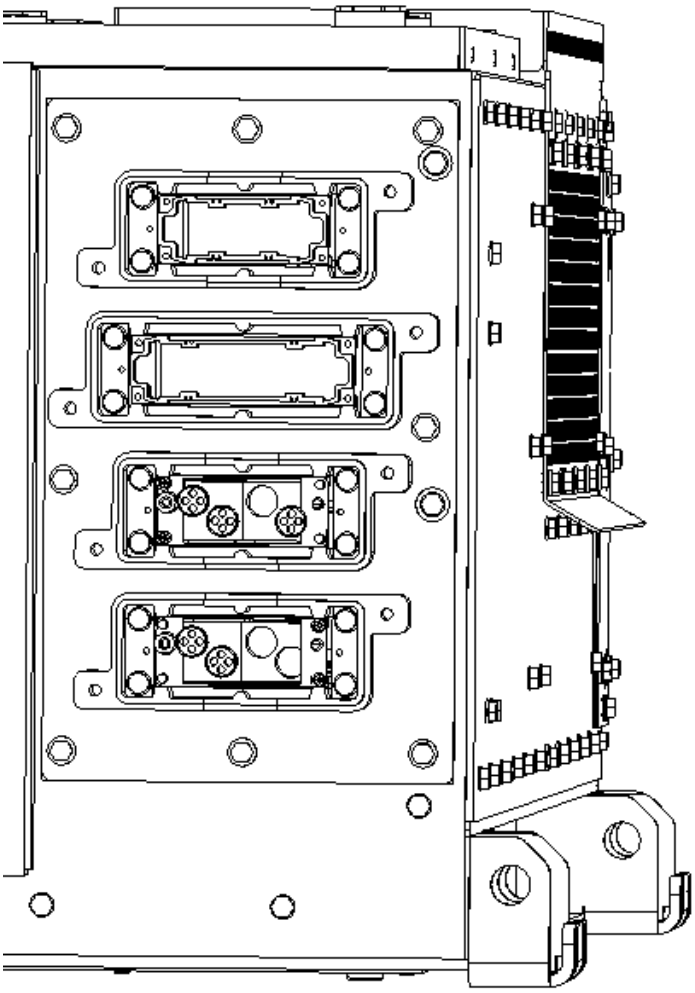
1. Pantograph
2. Surge arrestor
3. High Speed Circuit Breaker
4.
5.
6. Line contactor
7. Precharge circuit
8. Filter inductor
9. Line current sensor
10. Voltage sensor
11. Filter capacitor
12. Braking chopper
13. Braking resistor
14. Inverter
15. Electronic control (AC3mini)
16.
17. Motor current sensor
18. Traction motors (MAS or PMM)
19. PMM isolating contactors (only for PMM configuration)

On MAS and PMM architecture, a single AGATE rack controls both inverters.

2.4. LV Overview

2.4.1. Electrical connectors

Here below a front-view drawing of the electrical LV connectors plate.



X20. 72pin connector for resolver and speed sensor signals

X21. 108pin connector for all LV interfaces : power supply, command and feedback signals for single and double Agate configuration

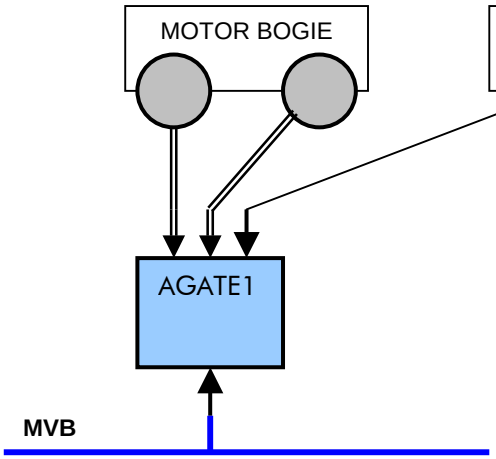
X22. MVB and Ethernet

X23. MVB (redundant line) and Ethernet (for 2AC3 configuration). *Not used in standard single Agate configuration*

On the next paragraphs, for each connector the complete signal list and electrical caracterictics is detailed.

2.4.2. X20 - Speed Signals

Speed informations come from proper speed sensors and/or resolvers (in case of PMMs); speed measuring devices are used for motor close loop torque control and vehicle speed estimation.
To guarantee good performance of the antislip-antislide control, Citadis speed architecture has been designed in order to have 4 independent speed information available for each Traction Unit; this solution covers possible fault conditions and degraded modes also.



Standard configuration
For each asynchronous motor a double speed sensor is required.
For each permanent magnet motor a position sensor is required.
From a trailed axle a single speed sensor is required.

2.4.2.1. Layout

1	MAS1 SP1 15V	13	MAS2 SP1 15V	25	MAS1 SP2 15V	37	MAS2 SP2 15V	49	AXLEADD1 15V	61	PMM1 SENL
2	MAS1 SP1 IN	14	MAS2 SP1 IN	26	MAS1 SP2 IN	38	MAS2 SP2 IN	50	AXLEADD1 SPD	62	PMM1 SENSH
3	MAS1 SP1 GND	15	MAS2 SP1 GND	27	MAS1 SP2 GND	39	MAS2 SP2 GND	51		63	
4	MAS1 SP1 SH	16	MAS2 SP1 SH	28	MAS1 SP2 SH	40	MAS2 SP2 SH	52	AXLEADD1 SH	64	PMM2 REFH
5		17		29		41		53		65	PMM2 REFL
6		18		30	AXLEADD2 15V	42		54	PMM1 REFH	66	PMM2 REFSH
7	AXLEM1 15V	19	AXLEM2 15V	31	AXLEADD2 SPD	43		55	PMM1 REFL	67	PMM2 COSH
8	AXLEM1 SPD	20	AXLEM2 SPD	32		44		56	PMM1 REFSH	68	PMM2 COSL
9		21		33	AXLEADD2 SH	45		57	PMM1 COSH	69	PMM2 COSSH
10	AXLEM1 SH	22	AXLEM2 SH	34		46		58	PMM1 COSL	70	PMM2 SENH
11		23		35		47		59	PMM1 COSSH	71	PMM2 SENL
12		24		36		48		60	PMM1 SENH	72	PMM2 SENSH

2.4.2.2. MAS configuration

Name	Description	X20 Pinout
MAS1 SP1	3wire (+shield) speed sensor installed on motor 1	1,2,3,4 (15V,IN,GND,Sh)
MAS1 SP2	3wire (+shield) speed sensor installed on motor 1	25,26,27,28 (15V,IN,GND,Sh)
MAS2 SP1	3wire (+shield) speed sensor installed on motor 2	13,14,15,16 (15V,IN,GND,Sh)
MAS2 SP2	3wire (+shield) speed sensor installed on motor 2	37,38,39,40 (15V,IN,GND,Sh)
AXLEADD1	2wire (+shield) speed sensor installed on a trailed axle for additional speed information	49,50,52 (15V,IN,Sh)

2.4.2.3. PMM configuration

Name	Description	X20 Pinout
PMM1	6wire (+shield) resolver installed on motor 1 **Remember to swap SENH and SENL connection on the vehicle (other wires shall follow the table)**	54,55,56 (RefH,RefL,Sh) 57,58,59 (CosH,CosL,Sh) 60,61,62 (SinH,SinL,Sh)
PMM2	6wire (+shield) resolver installed on motor 2 **Remember to swap SENH and SENL connection on the vehicle (other wires shall follow the table)**	64,65,66 (RefH,RefL,Sh) 67,68,69 (CosH,CosL,Sh) 70,71,72 (SinH,SinL,Sh)
AXLEADD1	2wire (+shield) speed sensor installed on a trailed axle for additional speed information	49,50,52 (15V,IN,Sh)

2.4.3. X21 - Battery Level Signals

On X21 connector all the battery level signals and battery supply pin are mapped.
Traction Unit is designed to use +24V DC nominal battery voltage, within a range between +16,8V to +30V; specific pins are defined to energize the electronic control, internal LV devices (contactors, relays …), and cooling fans.

2.4.3.1. Layout

1		NO_SB	19		ACCU2+	37		LOC_REF_IN	55			73		L_TEMP31	91		
2		L_RESCUE	20		ACCU2+	38		LO_BCUFAULT2	56			74		L_TEMP85	92		LO_BCURELAY
3		L_TRACTION	21			39		LO_BCUFAULT2	57			75		L_TEMP105	93		BCU_BAT
4		L_DIR1	22		HSCB_2NC	40		LO_ROLLBACK	58		HSCB_1NC	76		L_TEMP105_2	94		LO_LOCBR0
5		INV_ENABLE	23		ACCU-	41		LO_ROLLBACK	59		ACCU+	77		L_PRESSOSTAT	95		LI_BCUAPP
6			24		ACCU-	42		LO_TRACKBRAKE-	60		ACCU+	78		L_PUMP	96		LO_LOCBR1
7			25		NO_EMBR	43		LO_TRACKBRAKE-	61		L_APS	79		L_FANHS	97		LI_BCUREL
8		LV_BAT_IN	26			44			62		LO_APS	80		L_FAN1	98		LO_LOCBR2
9		PMFAN1_BAT	27		LOC2	45		PMFAN1_OV	63		LO_APS	81		L_WATERLVL1	99		LI_BCUISO
10		LV_BAT_IN2	28		LOC1	46		PMFAN2_OV	64			82		L_WATERLVL2	100		LO_LOCBR3
11		LO_SPARE11	29		LOC_REF	47		LO_SPARE12	65		ACCU2-	83		LO_GRFFAN	101		
12		LO_SPARE11	30		LOC3	48		LO_SPARE12	66		ACCU2-	84		LO_GRFFANHS	102		BCU_BAT2
13		L_NOBRAKE	31		INV_ENABLE2	49		DIR REVERSE	67		OVDC2	85		LO_GRFPUMP	103		LO_LOCBR02
14		LO_BCUFAULT	32		OVDC	50		DIR FORWARD	68			86		GRF_BAT	104		LO_LOCBR12
15		LO_BCUFAULT	33		PMFAN2_BAT	51		GOOD_DIR	69			87		L_SPARE1	105		LO_LOCBR22
16		L_DIR2	34		HSCB_2NC	52			70		HSCB_1NC	88		L_SPARE2	106		LO_LOCBR32
17		LO_TRACKBRAKE-	35		LOC_REF	53		LO_ZEROSPEED	71		GOOD_DIR2	89		L_SPARE3	107		L_BCURELAY2
18		LO_TRACKBRAKE-	36		LOC_REF	54		LO_ZEROSPEED	72		L_SPARE4	90		L_BCURELAY	108		LO_BCURELAY2

2.4.3.2. Power Supply

Name	Description	X21
ACCU+	2 pins to energize Agate rack	59, 60
ACCU-	2 pins return for ACCU+	23, 24
LV_BAT_IN	1 pin to energize internal LV devices (contactors, relays …)	8
0VDC	1 pin return for LV_BAT_IN	32
PM_FAN1_BAT	1 pin to energize power module fan	9
PM_FAN1_0V	1 pin return for power module fan	45
PM_FAN2_BAT	1 pin to energize power module fan	33
PM_FAN2_0V	1 pin return for power module fan	46
LOC_REF_IN	1 pin to energize LOC_REF pins	37
GRF_BAT	1 pin to energize output contacts for GRF control	86
BCU_BAT	1 pin to energize static output for BCU control	93

2.4.3.3. Digital Inputs

Name	Description	notes	X21
NO_SB	Safety Brake command	Active low (open circuit to SB)	1
L_RESCUE	Rescue Line **Optional for vehicle with RESCUE line.**	Active high	2
L_TRACTION	Traction command	Active high	3
L_DIR1	DIR1 command	Active high	4
L_DIR2	DIR2 command	Active high	16
INV_ENABLE	Pulse enable	Active high	5
L_NOBRAKE	Service brake command	Active low (open circuit to brake)	13
L_NOEMBR	Emergency brake command	Active low (open circuit to brake)	25
L_LOC1	Localization input	Active high	28
L_LOC2	Localization input	Active high	27
L_LOC3	Localization input	Active high	30
DIR_FORWARD	DIR1 selected by the driver	Active high	50
DIR_REVERSE	DIR2 selected by the driver	Active high	49
L_APS	Fast cut traction from APS computer	Active high	61
L_TEMP31	Temperature sensor from GRF **GRF is for standard MAS vehicle only.**	Active high (+BAT when T>31)	73
L_TEMP85	Temperature sensor from GRF	Active high (as above)	74
L_TEMP105	Temperature sensor from GRF	Active high (as above)	75
L_TEMP105_2	Temperature sensor from GRF	Active high (as above)	76
L_PRESSOSTAT	Water pressure sensor from GRF	Active low (open circuit with low pressure)	77
L_PUMP	Pump aux cont from GRF	Active high (pump aux cont from GRF)	78
L_FANHS	Fan HS aux cont from GRF	Active high (fan HS aux cont from GRF)	79
L_FAN1	Fan aux cont from GRF	Active high (fan aux cont from GRF)	80
L_WATERLVL1	Water level from GRF	Active low (open circuit with low level)	81
L_WATERLVL2	Water level from GRF	Active low (open circuit with low level)	82
L_SPARE1	Spare input avalable	Not defined	87
L_SPARE2	Spare input avalable	Not defined	88
L_SPARE3	Spare input avalable	Not defined	89
L_SPARE4	Spare input avalable	Not defined	72
L_BCURELAY	Aux contact from BCU bypass relay	Active high (+BAT when relay is energized)	90
L_BCUAPP	Mech brake applied from BCU	Active high	95
L_BCUREL	Mech brake released from BCU	Active high	97
L_BCUISO	Mech brake isolated from BCU	Active high	99

2.4.3.4. Digital Outputs

Name	Description	notes	X21
GOOD_DIR	Direction request has been decoded correctly (congruent with DIR_FORWARD or DIR_REVERSE)	**Two NO contacts** in parallel. Active high (+BAT when direction has been correctly decoded)	51
LO_BCUFAULT	Fault detected on local mech brake	**NO** contact. Close circuit when BCU fault	14,15
LO_TRACKBRAKE	Track brake control. **Only for DROC project.**	**Static** output. **+BAT shall be on X21-17**	17,18
HSCB_2NC	Contact for fast HSCB opening	**NC** contact. Close circuit to permit DJ close	22,34
HSCB_1NC	Contact for fast HSCB opening	**NC** contact. Close circuit to permit DJ close	58,70
LOC_REF	3 pins (internally connecter to LOC_REF_IN) for strap configuration		29,35, 36
LO_ROLLBACK	Rollback detected	**NO** contact. Close circuit when rollback	40,41
LO_ZEROSPEED	Zerospeed information	**Equivalent NC** contact (static output in parallel with NC). Close circuit when speed less than defined threshold. **+BAT shall be on X21-53**	53,54
LO_APS	Traction effort cut after APS request. **Optional for vehicles equipped with APS.**	**NC** contact. Close circuit when traction inhibited.	62,63
LO_BCURELAY	Command to control BCU relay. Internally connected to L_BCU_BAT	**Static** output. Close circuit in order to energize external BCU relay	92
LO_LOCBR0	Command for BCU. Internally connected to BCU_BAT.	**Static** output.	94
LO_LOCBR1	Command for BCU.	**Static** output.	96
LO_LOCBR2	Command for BCU.	**Static** output.	98
LO_LOCBR3	Command for BCU.	**Static** output.	100
LO_FAN	Fan command to GRF **GRF is for standard MAS vehicle only.**	**NO** contact.	83
LO_FANHS	Fan High Speed command to GRF	**Static** output.	84
LO_PUMP	Pump command to GRF	**Static** output.	85
LO_SPARE11	Available contact.	**NO** contact.	11,12

2.4.4. X22 & X23 - Vehicle Communication Busses

Traction Unit uses MVB for realtime communication with TCMS, and ethernet for diagnostic and maintenance activities; moreover, Alstom TrainTracer tool is compatible and fully supported by the Citadis Traction Control System.

2.4.4.1. Layout

X22A			X22B			X22C			X22D		
1		MVB_A1_DATAN	1		MVB_A2_DATAN	1			1		ETH-YELLOW
2			2			2			2		ETH-WHITE
3		MVB_A1_DATAP	3		MVB_A2_DATAP	3			3		ETH-ORANGE
4			4			4			4		ETH-BLUE

X23A			X23B			X23C			X23D		
1		MVB_B1_DATAN	1		MVB_B2_DATAN	1			1		ETH2-YELLOW
2			2			2			2		ETH2-WHITE
3		MVB_B1_DATAP	3		MVB_B2_DATAP	3			3		ETH2-ORANGE
4			4			4			4		ETH2-BLUE

2.4.4.2. MVB & Ethernet

Name	Description	X22
MVB_A1_DATAN	MVB line A1 – DATA N	A1
MVB_A1_DATAP	MVB line A1 – DATA P	A3
MVB_A2_DATAN	MVB line A2 – DATA N	B1
MVB_A2_DATAP	MVB line A2 – DATA P	B3
ETH-YELLOW	Standard Ethernet 4 wire cable	D1
ETH-WHITE		D2
ETH-ORANGE		D3
ETH-BLUE		D4

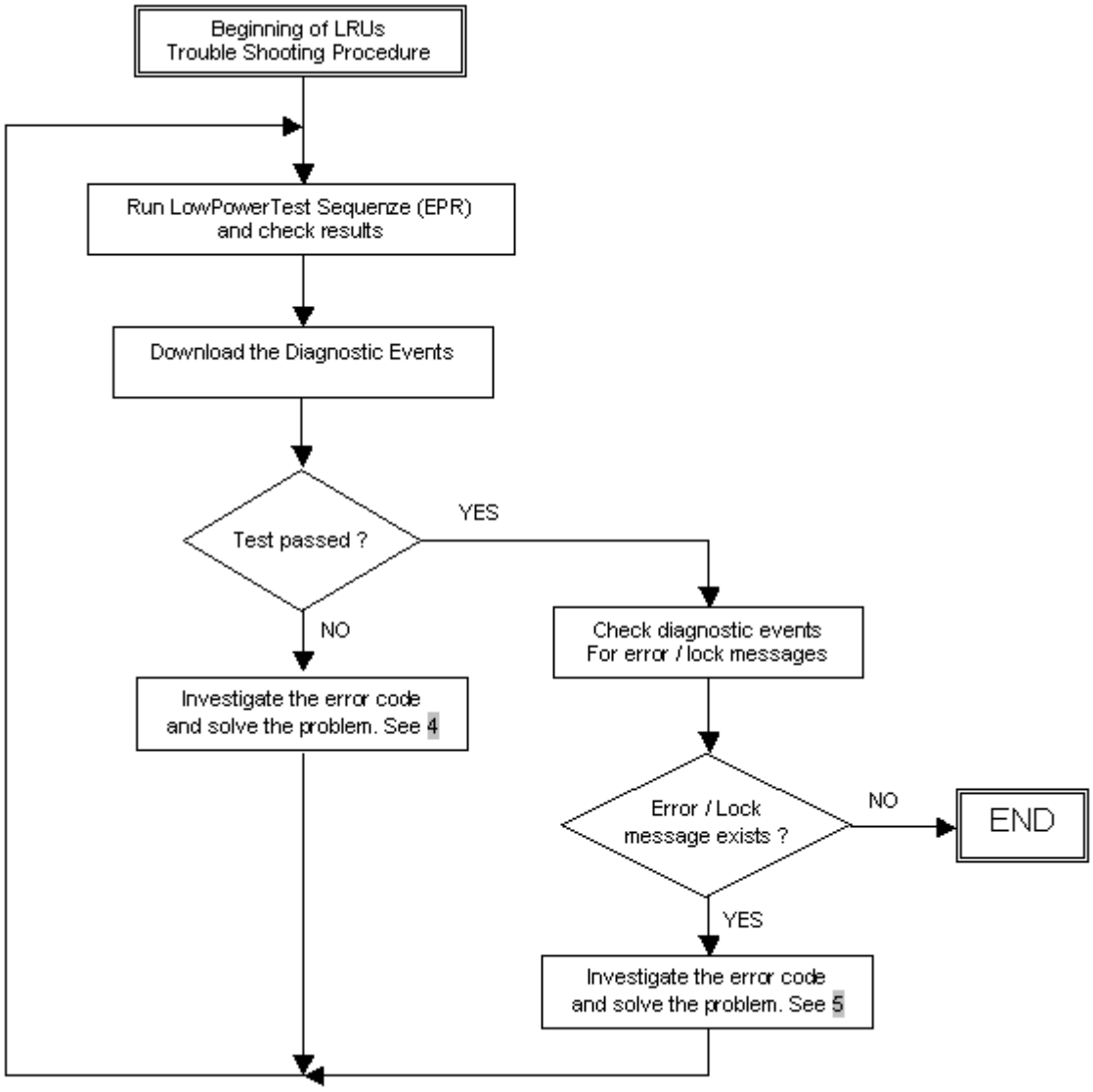
Name	Description	X23
MVB_B1_DATAN	MVB line B1 – DATA N	A1
MVB_B1_DATAP	MVB line B1 – DATA P	A3
MVB_B2_DATAN	MVB line B2 – DATA N	B1
MVB_B2_DATAP	MVB line B2 – DATA P	B3

3. Troubleshooting Process

3.1. Introduction

Citadis Traction SW stores in permanent memory events and fault messages, in order to simplify maintenance and troubleshooting activities.
Events are stored with a time stamp and can be filtered to highlight faults or simple diagnostic events.
As for the TCMS Control Platform, diagnostic events can be downloaded using the standard TrainTracer tool.

To approach the troubleshooting process, the suggested way of working to should follow these steps:

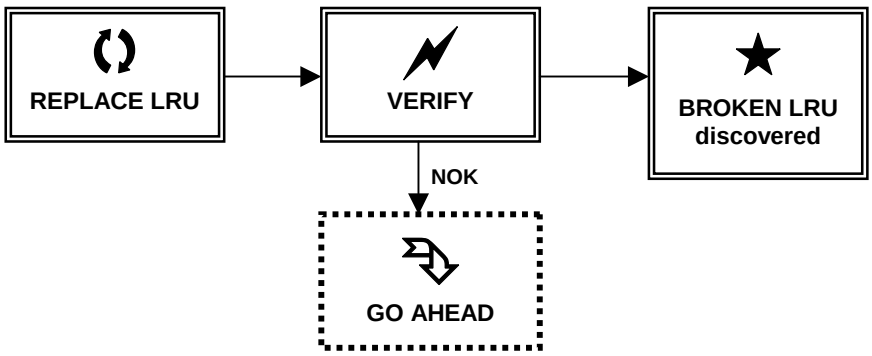


3.2. Replace and Test approach

This troubleshooting manual follows a simple but effective approach to identify faults and fix them, describing a list of activities which can be classified in :

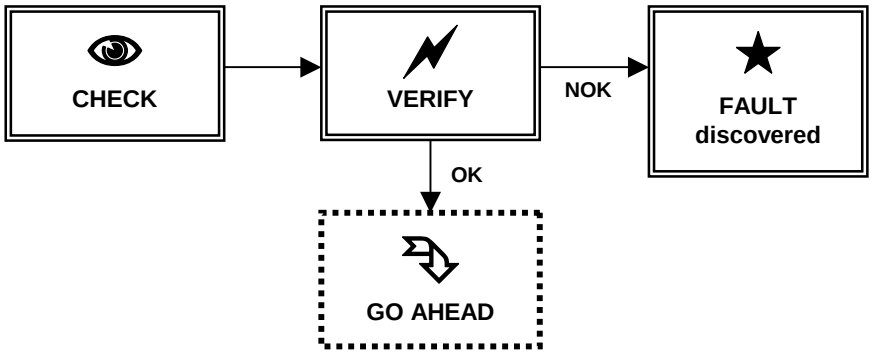
Replace and Verify

Replace the supposely broken LRU and make a specific test to validate the hypotesis.
If the test result is positive, the replaced LRU was effectively in fault.
In the other case, restore the original LRU and go ahead for the next troubleshooting step.



Check and Verify

Check wiring or measure electrical parameters.
If the acceptance criteria is passed, go ahead for the next troubleshooting step.
In case of error, fix the issue (i.e. wiring repair, LRU replacement).



3.3. List of tools used for investigations

- A standard Windows PC, equipped with TrainTracer UTM Alstom Maintenance SW Tool
- The specific Train Tracer .etr file related to the Traction SW version installed on the vehicle
- A standard Ethernet cable to connect the PC with the vehicle local network
- A multimeter
- Mechanical tools for mounting and dismounting stuffs
- Electrical HV and LV detailed schemes
- This Troublesooting Manual

3.4. How to download diagnostic messages

On the next, a detailed procedure to download diagnostic events is described.
Take care that the initial steps (from 1 to 3) are required to configure for the first time the PC with the diagnostic messages database related to the SW version in use (project importing).
If the TrainTracer database in the local PC is update, you have just to download the event list following steps starting from 4.

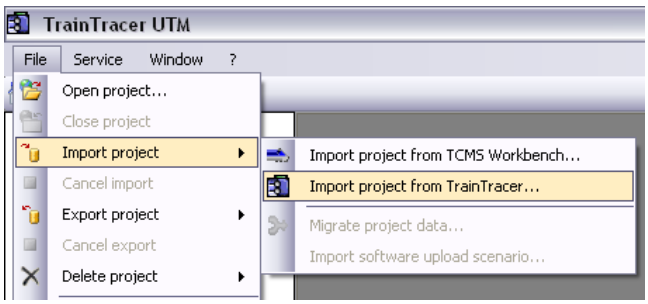
The CarBuilder (that manages TCMS) could provides a merged TrainTracer Database which integrates TCMS and Traction equipment configuration. In this case you can use this specific TrainTracer project file to download at the same time diagnostic events for all the devices.

1. Unzip the zip file related to the SW version installed in the Traction Converter; 2 folders will be generated:

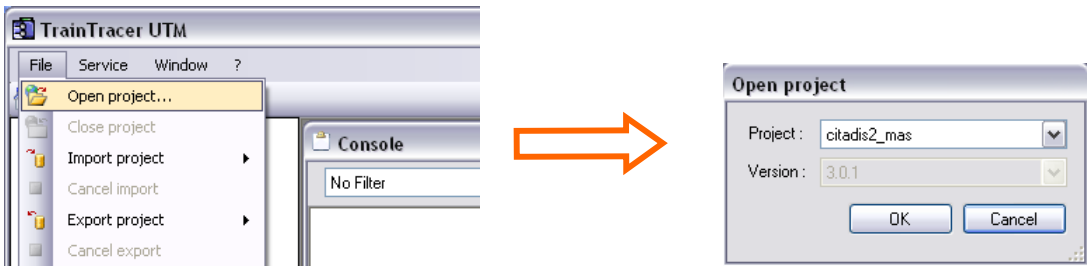
USB_data
USB_image

2. Run TrainTracerUTM on the PC

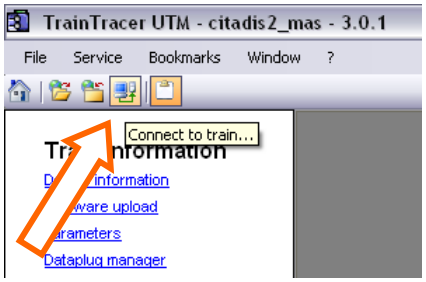
3. Import the traintracer project file (*.etr file) localed in USB_data/eTrain (Menu File>Import project>Import project from TrainTracer …)



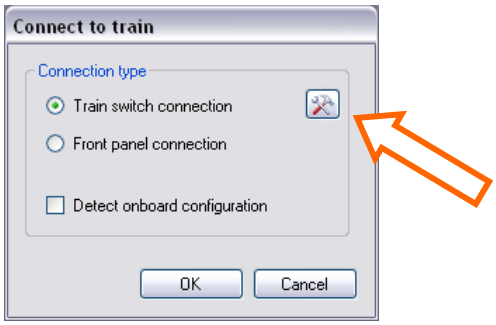
4. At the end of the process, Open the previously imported project



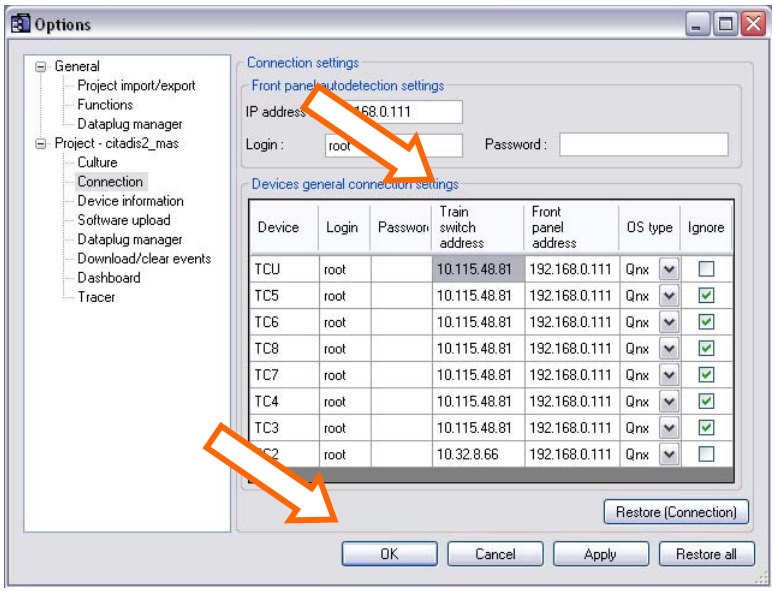
5. Connect the PC to the ethernet Train network, and then click the Connect icon



6. A message box appears, select Train switch connection, then press 

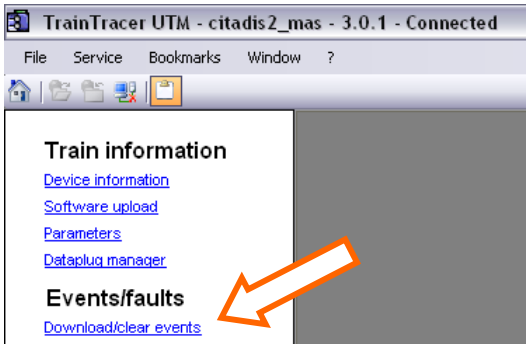


7. The Option window appears, where you have to specify the IP address (Train switch address) of each Agate3mini available on the vehicle. Use Ignore check button to exclude Agate units not available on the train (this reduce connection times, because TrainTracer skip these units). After all settings press OK button.

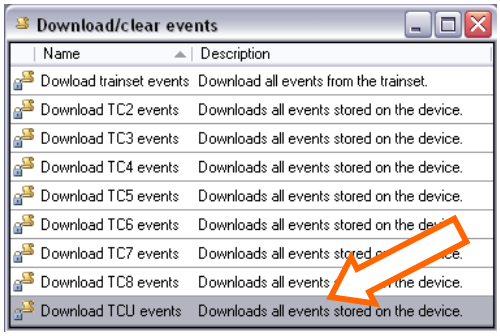


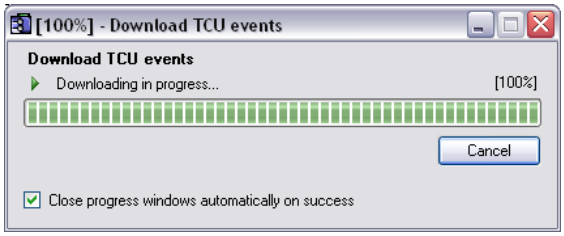
8. Press OK button in the already open Connect to Train window; after few seconds TrainTracerUTM will inform about the established connection with the icon  .

9. Press Download/Clear events on the left Menu



10. The following window appears with the available upload scripts (scenarios). Select Upload code to TCU, then press Execute Scenario  in the button bar. A pop-up window will show the progress ongoing.





specific scenarios can be created, useful i.e. to download or clear events from many devices at the same time. Expecially the possibility to have, in the same list, events from both the TBCU could be useful in many cases

3.5. Understanding diagnostic messages

3.5.1. Event Stack

The Traction SW contains ten event's stacks:
- two are used by OPERA/Libraries software
- four are used for system monitoring
- four are used by ControlBuild application

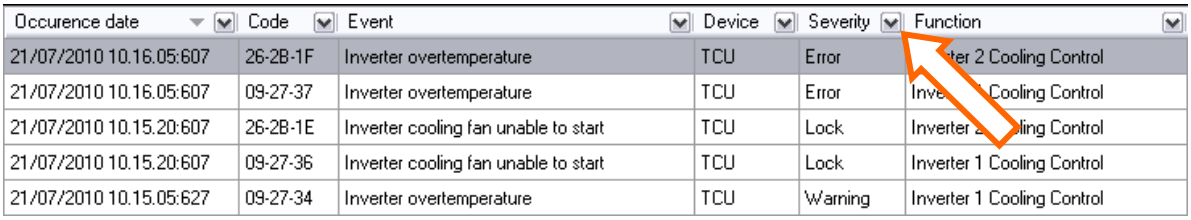
Event Stack		Comment
System	OPERA	Information
Systeme		
CB_alarm	SYSTEM MONITORING	STR 3.0 : information or error STR 3.1 : information
CB_ventil		TCU or COOLING FAN Tray Error
CB_system		TCU Error
CB_powerup		Information
CB_error	APPLICATION	Reserved for application (contact TCE for detail)
CB_warning		Reserved for application (contact TCE for detail)
CB_message		Reserved for application (contact TCE for detail)
CB_lock		Reserved for application (contact TCE for detail)

Recorded events don't necessarily traduce an error, it could also represent an information or a message.
In example, CB_powerup stack is used to record, at each power-up, the FLT_syst_power_up event, which stores information about CPU temperature, working hours, cumulative kilometres and so on …

3.5.2. Filtering Events

When diagnostic messages have been downloaded in the PC memory, you can analyze them immediately or save and sent to colleagues.
Many features are available, in particular the possibility to filter events in order to highlight message related to a specific functionality (i.e. messages related to the mechanical brake control), or based on a severity criteria (i.e. messages related to a Lock event).

A small button is used for filtering.
Mouse click on a colums title permits to order events.



Occurence date	Code	Event	Device	Severity	Function
21/07/2010 10.16.05:607	26-2B-1F	Inverter overtemperature	TCU	Error	ter 2 Cooling Control
21/07/2010 10.16.05:607	09-27-37	Inverter overtemperature	TCU	Error	Inve Cooling Control
21/07/2010 10.15.20:607	26-2B-1E	Inverter cooling fan unable to start	TCU	Lock	Inverter ling Control
21/07/2010 10.15.20:607	09-27-36	Inverter cooling fan unable to start	TCU	Lock	Inverter 1 Cooling Control
21/07/2010 10.15.05:627	09-27-34	Inverter overtemperature	TCU	Warning	Inverter 1 Cooling Control

4. Low Power Test

Several hardware faults can be identifed executing the Low Power Test Sequence (EPR), then checking the final result; anomalous behavior is traced highlighting on the DDU the related faulty step code. Refer to the TCMS UserManual for detailed information regarding Low Power Test activation procedure.

4.1. Low Power Test step codes

When the Low Power Test start command comes from TCMS (via DDU button, accessible on the maintenance page), Traction SW checks that the necessary precondition are verified (vehicle stopped, manipulator in coasting) before activating the test sequences.

During the test phase the driver is informed (on the DDU screen) about the progress of the sequence by a numeric code related to the test actually ongoing.

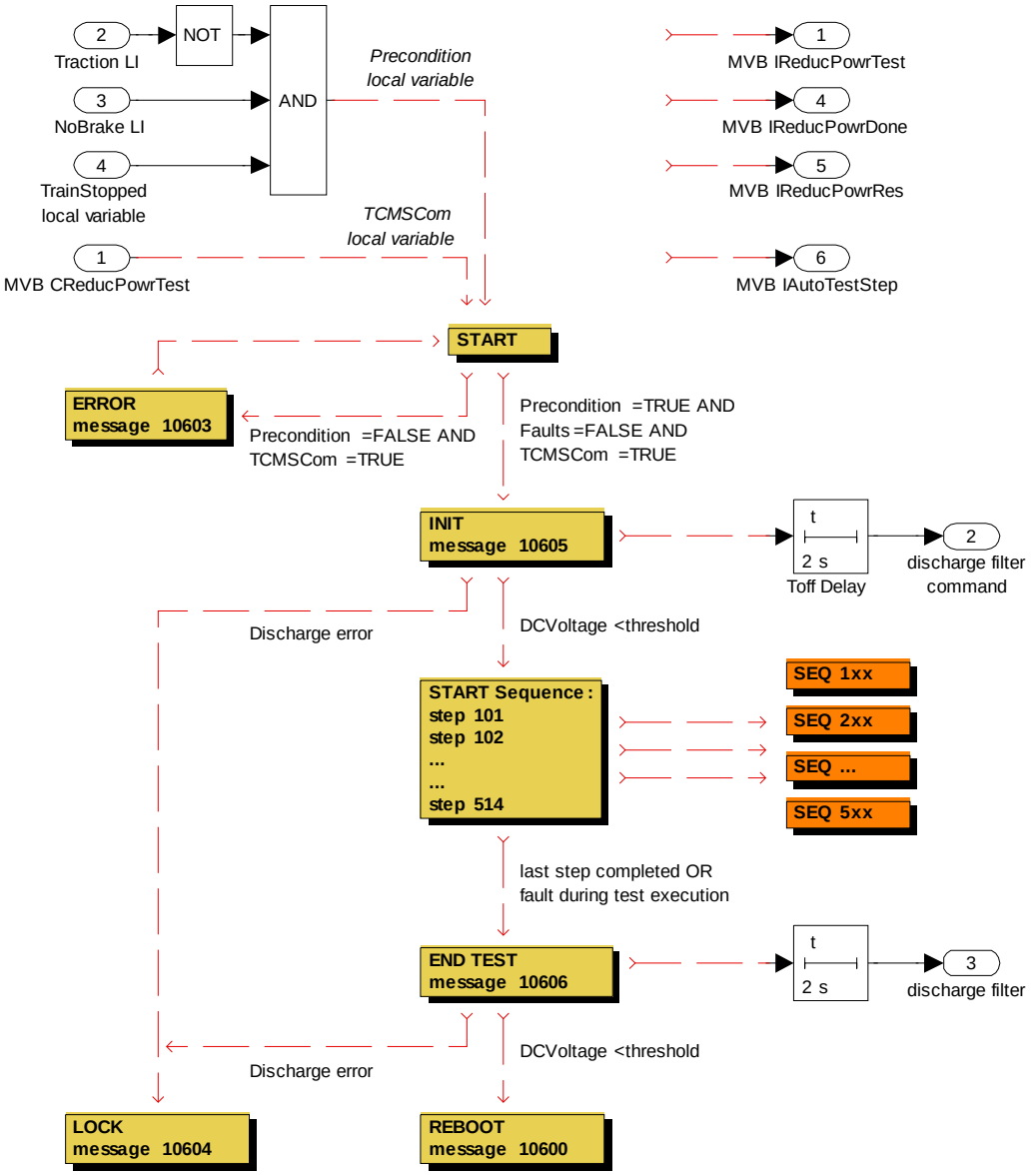
Step	Test	Ref
-	GRF test sequence starts	4.3
101	Activate pump	
102	If pump doesn't start (aux contact =false) trigger an error and stop test	
103	Switch-off pump	
104	If pump doesn't stop (aux contact =true) trigger an error and stop test	
105	Activate fan	
106	If fan doesn't start (aux contact =false) trigger an error and stop test	
107	Activate high speed fan	
108	If fan doesn't run at high speed (aux contact =false) trigger an error and stop test	
109	Switch-off fan	
110	If fan continue to run at normal speed (aux contact =true) trigger an error and stop test	
	If fan continue to run at high speed (aux contact =true) trigger an error and stop test	
-	GRF test sequence complete	
-	PowerModule Cooling test sequence starts	4.4
201	Activate fans	
202	If fan1 doesn't start (aux contact =false) trigger an error and stop test	
	If fan2 doesn't start (aux contact =false) trigger an error and stop test	
	If high speed static output is in fault trigger an error and stop test	
203	Switch-off fans	
204	If fan1 continue to run (aux contact =true) trigger an error and stop test	
	If fan2 continue to run (aux contact =true) trigger an error and stop test	
-	PowerModule Cooling test sequence complete	
-	PowerModule Protections test sequence starts	4.5
301	If inverter1 Gate Unit is in fault trigger an error and stop test	
	If braking chopper1 Gate Unit is in fault trigger an error and stop test	
	If inverter2 Gate Unit is in fault trigger an error and stop test	
	If braking chopper2 Gate Unit is in fault trigger an error and stop test	
302	If thermoswitch inverter1 detect overtemperature trigger an error and stop test	
	If thermoswitch inverter2 detect overtemperature trigger an error and stop test	
-	PowerModule Protections test sequence complete	
-	PowerModule Transducers test sequence starts	4.6
401	If M1R current sensor measured value is above a threshold, trigger an error and stop test	
	If M1S current sensor measured value is above a threshold, trigger an error and stop test	
	If M2R current sensor measured value is above a threshold, trigger an error and stop test	
	If M2S current sensor measured value is above a threshold, trigger an error and stop test	
402	If DCCurrPos sensor measured value is above a threshold, trigger an error and stop test	
	If DCCurrNeg sensor measured value is above a threshold, trigger an error and stop test	
403	If DCVoltage sensor measured value is above a threshold, trigger an error and stop test	
-	PowerModule Transducers test sequence complete	
-	Speed transducers test sequence starts	4.7
501	If speed sensor channel 1 is in fault, trigger an error and stop test	
	If speed sensor channel 2 is in fault, trigger an error and stop test	
	If speed sensor channel 3 is in fault, trigger an error and stop test	
	If speed sensor channel 4 is in fault, trigger an error and stop test	
	If speed sensor channel 5 is in fault, trigger an error and stop test	
	If speed sensor channel 6 is in fault, trigger an error and stop test	
-	Speed transducers test sequence complete	

-	Contactors test sequence starts	4.8
601	Close precharge contactor	
602	If DCVoltage<threshold AND precharge aux contact=False, trigger an error and stop test	
	If DCVoltage<threshold AND precharge aux contact=True, trigger an error and stop test	
	If DCVoltage>threshold, close line contactor	
603	Open precharge contactor	
	If line aux contact=False, trigger an error and stop test	
	If line aux contact=True, precharge phase is correct	
604	Inhibit braking chopper2 and set braking chopper1 dutycycle to a fixed value	
605	If measured DCCurrPos is out of the expected range, trigger an error and stop test	
	If measured DCCurrNeg is out of the expected range, trigger an error and stop test	
606	Switch-off chopper1 and remove inhibition chopper2	
607	Inhibit braking chopper1 and set braking chopper2 dutycycle to a fixed value	
608	If measured DCCurrPos is out of the expected range, trigger an error and stop test	
	If measured DCCurrNeg is out of the expected range, trigger an error and stop test	
609	Switch-off chopper2 and remove inhibition chopper1	
610	Close M1 contactor and M2 contactor	
611	If M1 contactor aux contact=false, trigger an error and stop test	
	If M2 contactor aux contact=false, trigger an error and stop test	
612	Open M1 and M2 contactors	
613	If M1 contactor aux contact=true, trigger an error and stop test	
	If M2 contactor aux contact=true, trigger an error and stop test	
614	Close again M1 and M2 contactors	
-	Contactors test sequence complete	

4.2. Main Test Sequence

4.2.1. Description

Here below the detailed state diagram related to the main autotest function, that prepares the Traction Unit for test execution and perform a reboot at the end of the test, in order to put again the Traction System in normal mode.



The following messages will trace in the diagnostic memory the test steps.

TrainTracerCode	Stack	Text message
xx-29-68	Message	AC3 Reboot after test sequence
xx-29-69	Message	Test Fault
xx-29-6A	Message	Test stopped due to lack of precond
xx-29-6B	Message	Test start command without precond
xx-29-6C	Message	Traction Lock due to severe Test Fault
xx-29-6D	Message	Start low power test main sequence
xx-29-6E	Message	End low power test main sequence

4.3. Autotest – GRF

4.3.1. Description

This sequence check proper functionalities of the GRF unit.
It controls pump and fan and verify the correct behaviour reading the available auxiliary contacts information.

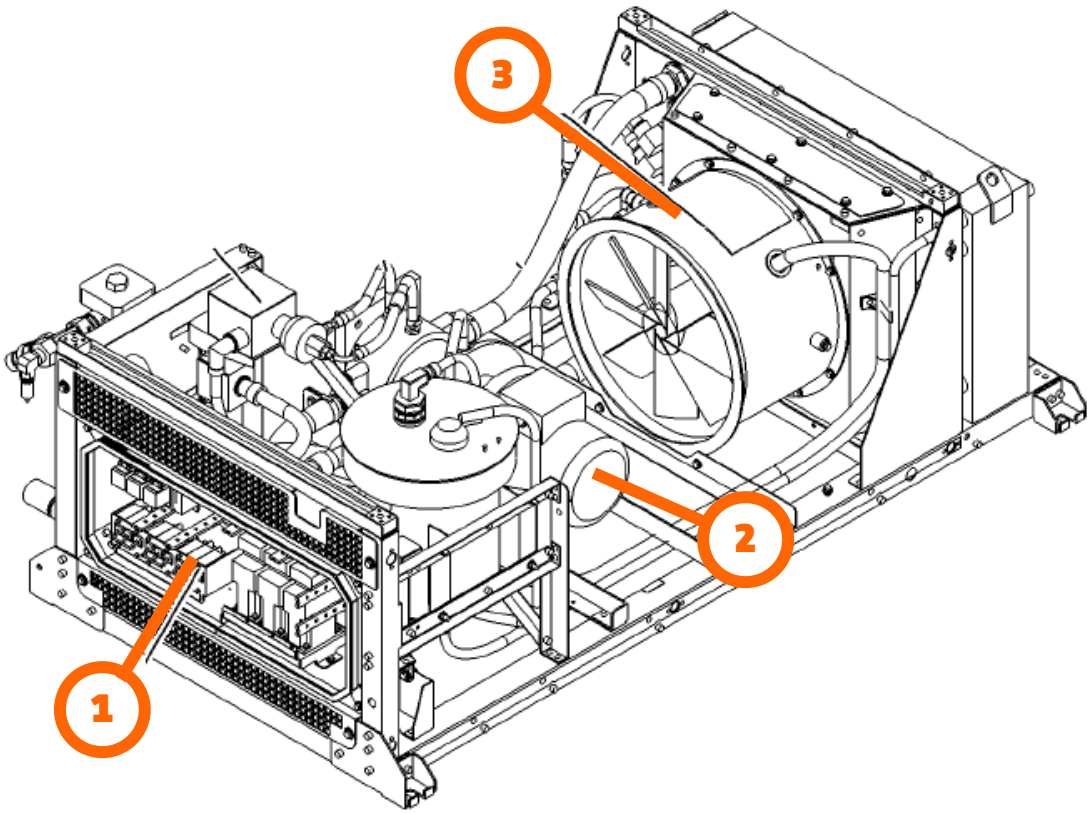
Step	Test	TrainTracerCode
-	GRF test sequence starts	xx-29-06
101	Activate pump	-
102	If pump doesn't start (aux contact =false) trigger an error and stop test	xx-29-08
103	Switch-off pump	-
104	If pump doesn't stop (aux contact =true) trigger an error and stop test	xx-29-09
105	Activate fan	-
106	If fan doesn't start (aux contact =false) trigger an error and stop test	xx-29-0D
107	Activate high speed fan	-
108	If fan doesn't run at high speed (aux contact =false) trigger an error and stop test	xx-29-0F
109	Switch-off fan	
110	If fan continue to run at normal speed (aux contact =true) trigger an error and stop test	xx-29-0E
	If fan continue to run at high speed (aux contact =true) trigger an error and stop test	xx-29-10
-	GRF test sequence complete	xx-29-07

The following messages will trace in the diagnostic memory the test steps.

TrainTracerCode	Stack	Text message
xx-29-06	Message	`Start test GRF`
xx-29-07	Message	`End test GRF`
xx-29-08	Message	`GRF pump UnableToStart or contactor Flt`
xx-29-09	Message	`GRF pump UnableToStop or contactor Stuck`
xx-29-0D	Message	`GRF Fan UnableToStart or contactor Flt`
xx-29-0E	Message	`GRF Fan UnableToStop or contactor Stuck`
xx-29-0F	Message	`GRF FanHS UnableToStart or contactor Flt`
xx-29-10	Message	`GRF FanHS UnableToStop or contactor Stk`

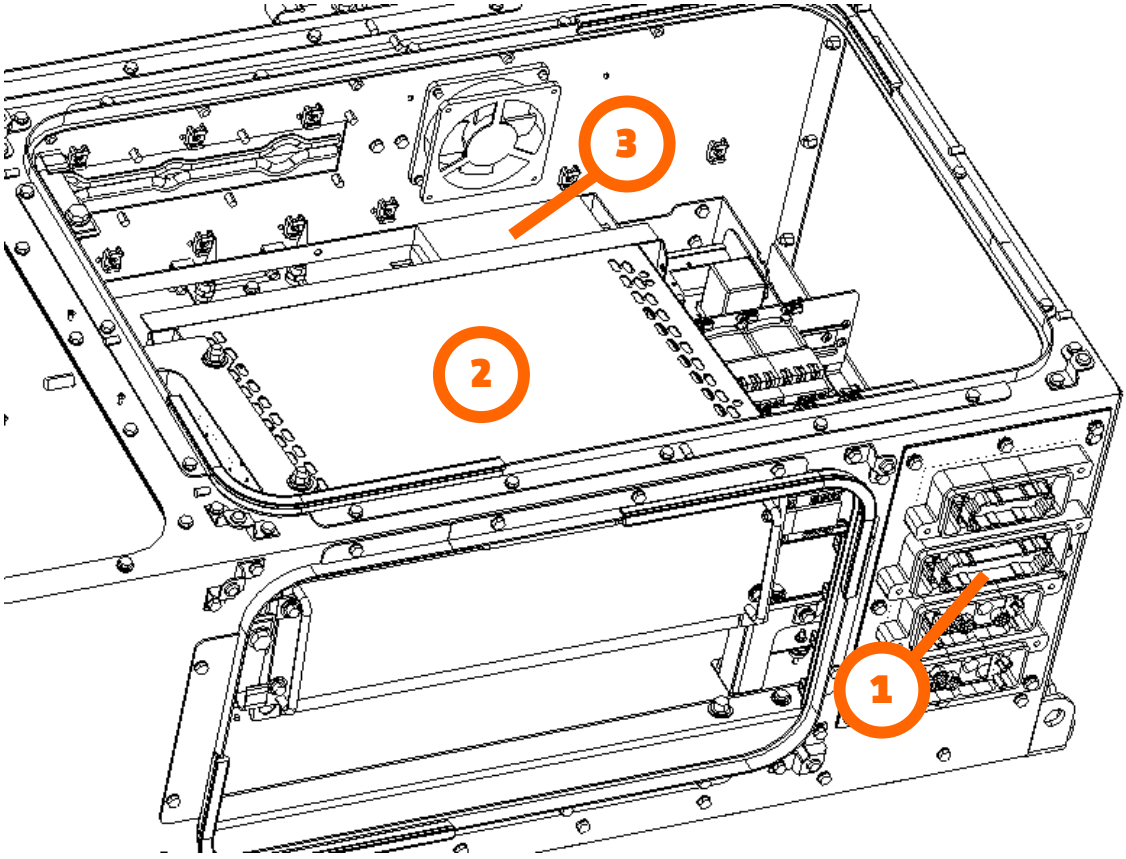
4.3.2. Involved LRUs

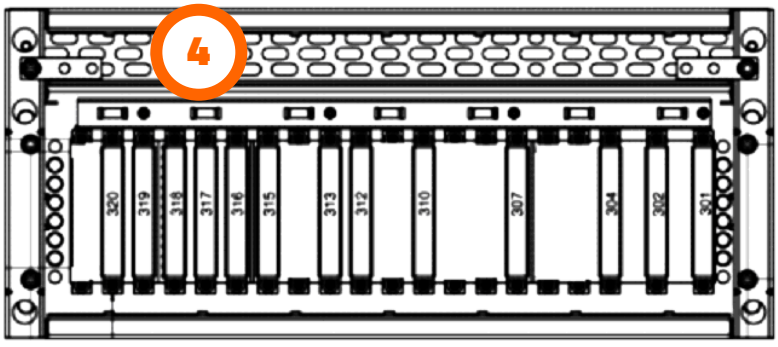
4.3.2.1. GRF

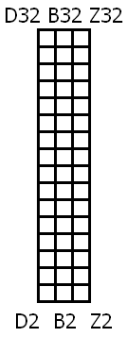


POS	Description	
1	Thermal protection (moto-pump)	**RM-11K3**
	Three phase contactor for pump	**11K3**
	Thermal protection (moto-fan PV)	**RM-11K2**
	Three phase contactor	**11K2**
	Thermal protection (moto-fan GV)	**RM-11K1**
	Three phase contactor	**11K1**
2	MOTOR PUMP	**11M3**
3	MOTOR FAN	**11M2**

4.3.2.2. TBCU



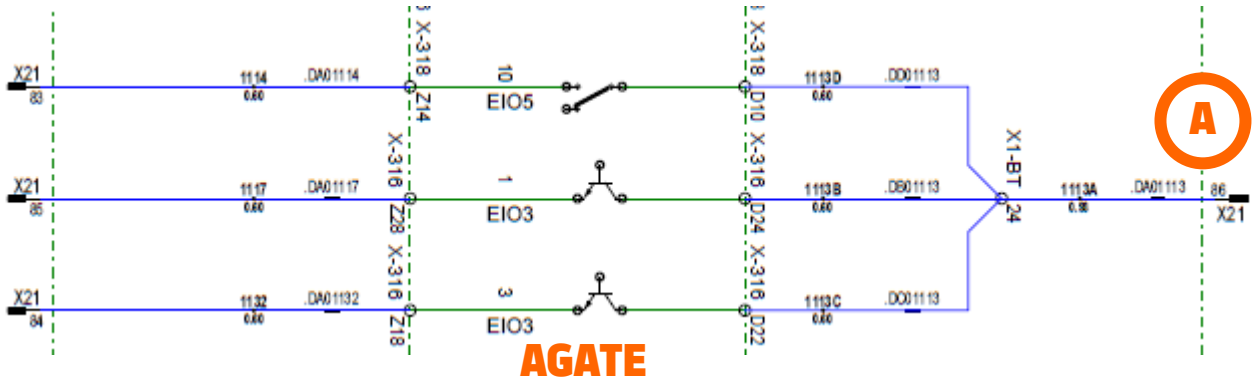




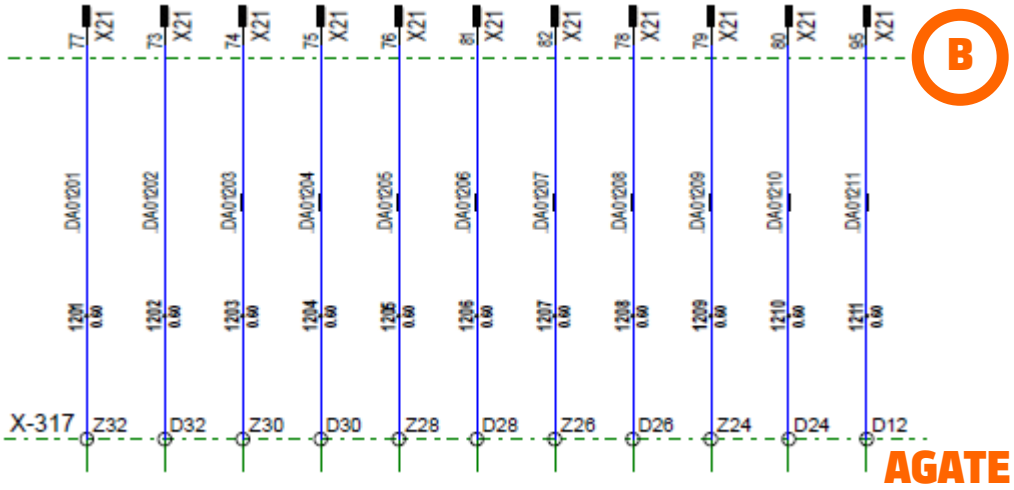
POS	Description	
1	BT connector	**X21**
2	AGATE	**AC3mini**
3	Internal BT connector	**X1-BT**
4	AGATE backplane layout	

4.3.2.3. TBCU LV Scheme

Name	Description	notes	X21
LO_FAN	Fan command to GRF	**NO** contact.	83
LO_FANHS	Fan High Speed command to GRF	**Static** output.	84
LO_PUMP	Pump command to GRF	**Static** output.	85



Name	Description	notes	X21
L_PUMP	Pump aux cont from GRF	Active high (pump aux cont from GRF)	78
L_FANHS	Fan HS aux cont from GRF	Active high (fan HS aux cont from GRF)	79
L_FAN1	Fan aux cont from GRF	Active high (fan aux cont from GRF)	80



A. Battery voltage shall be present on X21-86 in order to energize the digital outputs which controls pump and fan (low and high speed)

B. GRF relays status are acquired directly by specific digital inputs of the Agate (board 317)

4.3.2.4. Winscope / Traintracer TDB

Use **AutotestGRF.tdb** to support investigation.
Follow on-screen notes in order to:

- Start and stop cooling pump, verifying correct feedback
- Start and stop cooling fan at low speed, verifying correct feedback
- Start and stop cooling fan at high speed, verifying correct feedback

4.3.3. Verifications - Failure 102

Involved LRUs		
TBCU	AGATE	**AC3mini**
GRF	Thermal protection (moto-pump)	**RM-11K3**
	Three phase contactor	**11K3**
	Pump	-
	Pump motor	**11M3**

4.3.3.1. Message xx-29-08. GRF pump UnableToStart or contactor Flt

AC3mini controls **11K3** (which activates GRF motor pump) and read status of the contactor aux contact.

1 ***CHECK*** thermal protection of the motor pump **RM-11K3**; in case of thermal protection trip, re-arm it
VERIFY that pump rotation is smooth

2 ***REPLACE*** **11K3**
activate the pump and ***VERIFY*** consistency between contactor command and feedback

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
activate the pump and ***VERIFY*** consistency between contactor command and feedback

4 ***CHECK*** internal and external cabling
VERIFY that electrical connections are good

5 ***REPLACE*** motor pump

4.3.4. Verifications - Failure 104

Involved LRUs		
TBCU	AGATE	**AC3mini**
GRF	Three phase contactor	**11K3**

4.3.4.1. Message xx-29-09. GRF pump UnableToStop or contactor Stuck

AC3mini controls **11K3** (which activates GRF motor pump) and read status of the contactor aux contact.

1 ***REPLACE*** **11K3**
VERIFY consistency between contactor command and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY consistency between contactor command and feedback

3 ***CHECK*** internal and external cabling
VERIFY that electrical connections are good

4.3.5. Verifications - Failure 106

Involved LRUs		
TBCU	AGATE	**AC3mini**
GRF	Thermal protection (moto-fan PV)	**RM-11K2**
	Three phase contactor	**11K2**
	Motor-fan	**11M2**

4.3.5.1. Message xx-29-0D. GRF Fan UnableToStart or contactor Flt

AC3mini controls **11K2** (which activates GRF reduced speed motor fan) and read status of the contactor aux contact.

1 ***CHECK*** thermal protection of the motor fan **RM-11K2**; in case of thermal protection trip, re-arm it
VERIFY that fan rotation is smooth

2 ***REPLACE*** **11K2**
activate the fan and ***VERIFY*** consistency between contactor command and feedback

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
activate the fan and ***VERIFY*** consistency between contactor command and feedback

4 ***CHECK*** internal and external cabling
VERIFY that electrical connections are good

5 ***REPLACE*** motor fan **11M2**

4.3.6. Verifications - Failure 108

Involved LRUs		
TBCU	AGATE	**AC3mini**
GRF	Thermal protection (moto-fan GV)	**RM-11K1**
	Three phase contactor	**11K1**

4.3.6.1. Message xx-29-0F. GRF FanHS UnableToStart or contactor Flt

AC3mini controls **11K1** (which activates GRF high speed motor fan) and read status of the contactor aux contact.

1 ***CHECK*** thermal protection of the motor fan **RM-11K1**; in case of thermal protection trip, re-arm it
VERIFY that fan rotation is smooth

2 ***REPLACE*** **11K1**
activate the fan and ***VERIFY*** consistency between contactor command and feedback

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
activate the fan and ***VERIFY*** consistency between contactor command and feedback

4 ***CHECK*** internal and external cabling
VERIFY that electrical connections are good

5 ***REPLACE*** motor fan **11M2**

4.3.7. Verifications - Failure 110

Involved LRUs		
TBCU	AGATE	**AC3mini**
GRF	Three phase contactor	**11K1**
	Three phase contactor	**11K2**

4.3.7.1. Message xx-29-0E. GRF Fan UnableToStop or contactor Stuck

AC3mini controls **11K2** (which activates GRF motor fan) and read status of the contactor aux contact.

1 ***REPLACE*** **11K2**
VERIFY consistency between contactor command and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY consistency between contactor command and feedback

3 ***CHECK*** internal and external cabling
VERIFY that electrical connections are good

4.3.7.2. Message xx-29-10. GRF FanHS UnableToStop or contactor Stk

AC3mini controls **11K1** (which activates GRF motor fan) and read status of the contactor aux contact.

1 ***REPLACE*** **11K1**
VERIFY consistency between contactor command and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY consistency between contactor command and feedback

3 ***CHECK*** internal and external cabling
VERIFY that electrical connections are good

4.4. Autotest – PowerModule Cooling

4.4.1. Description

This sequence check proper functionalities of the powermodule cooling fans.
It controls fans and verify correct behaviour reading the available status signal.

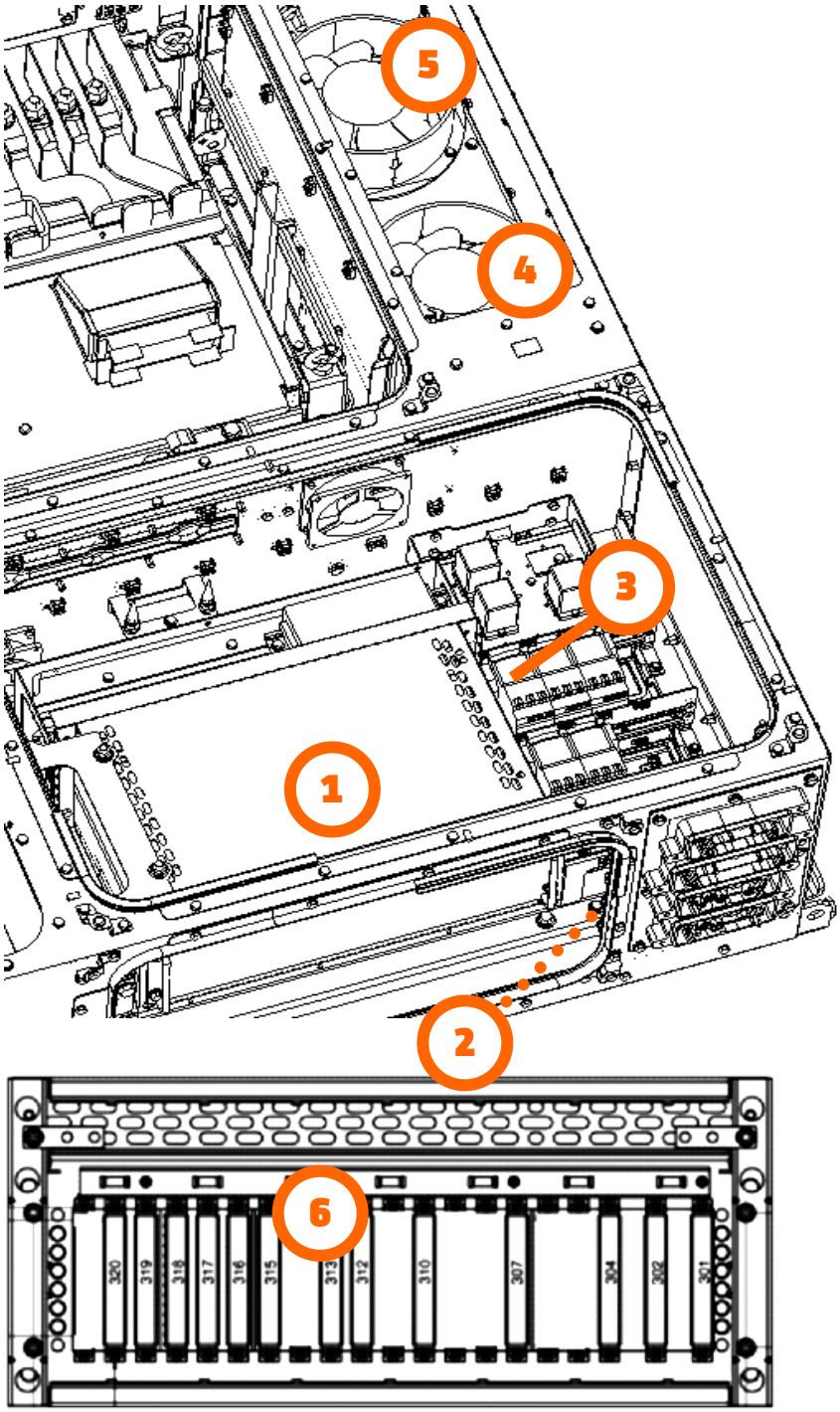
Step	Test	TrainTracerCode
-	PowerModule Cooling test sequence starts	xx-29-11
201	Activate fans	-
202	If fan1 doesn't start (aux contact =false) trigger an error and stop test	xx-29-14
	If fan2 doesn't start (aux contact =false) trigger an error and stop test	xx-29-15
	If high speed static output is in fault trigger an error and stop test	xx-29-13
203	Switch-off fans	-
204	If fan1 continue to run (aux contact =true) trigger an error and stop test	xx-29-16
	If fan2 continue to run (aux contact =true) trigger an error and stop test	xx-29-17
-	PowerModule Cooling test sequence complete	xx-29-12

The following messages will trace in the diagnostic memory the test steps.

TrainTracerCode	Stack	Text message
xx-29-11	Message	Start test Power Module Cooling Fan
xx-29-12	Message	End test Power Module Cooling Fan
xx-29-13	Message	PMC Fan DO for High Speed fault
xx-29-14	Message	PMC Fan1 UnableToStart or contactor Flt
xx-29-15	Message	PMC Fan2 UnableToStart or contactor Flt
xx-29-16	Message	PMC Fan1 UnableToStop or contactor Stuck
xx-29-17	Message	PMC Fan2 UnableToStop or contactor Stuck

4.4.2. Involved LRUs

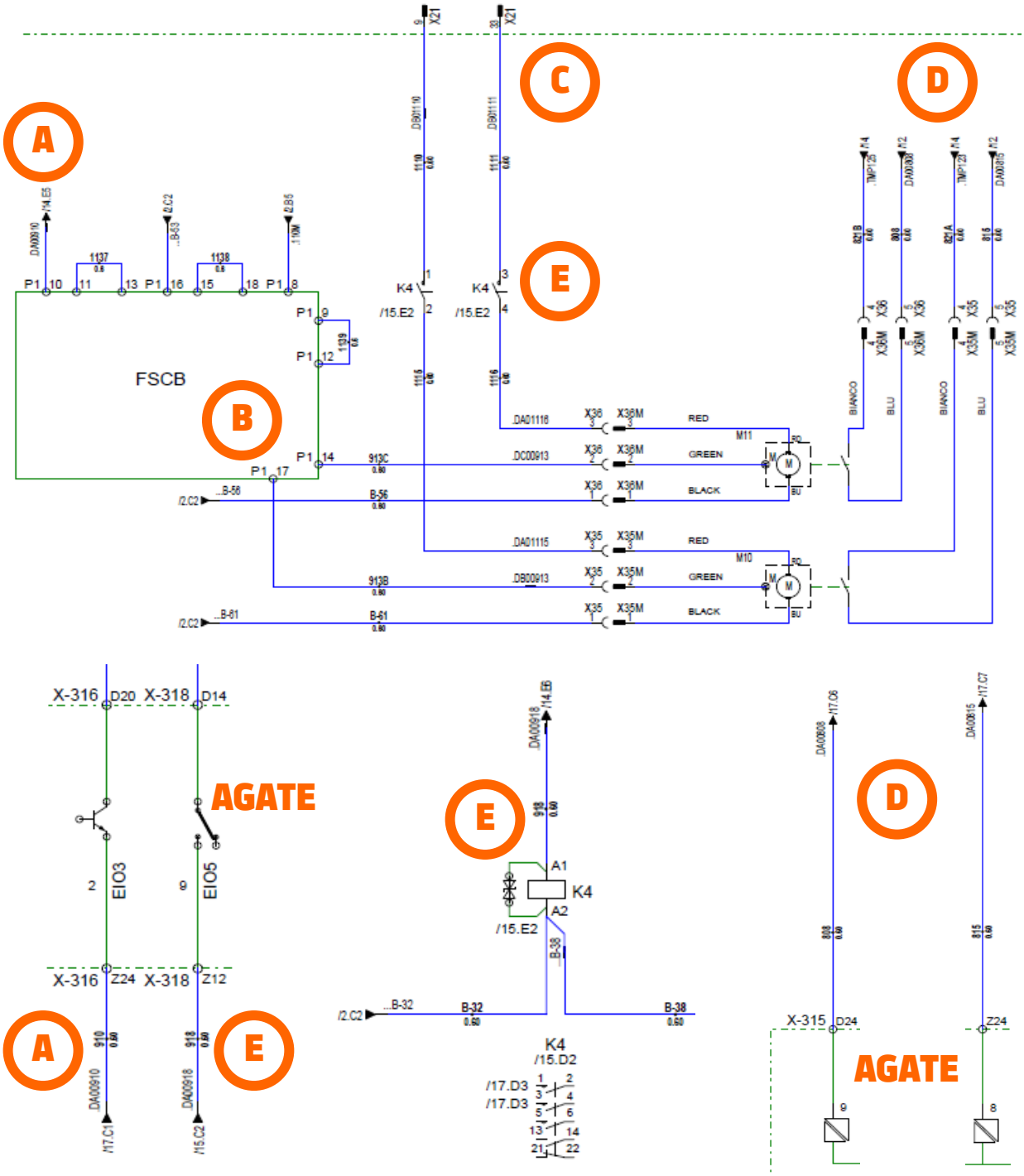
4.4.2.1. TBCU



POS	Description	
1	AGATE	**AC3mini**
2	Fan speed control board	**FSCB**
3	LV contactor LC1D126BLS170	**K4**
4	Power module fan (MF)	**M1PM**
5	Power module fan (MF)	**M2PM**
6	AGATE backplane layout	

4.4.2.2. TBCU LV Scheme

Name	Description	X21
PM_FAN1_BAT	1 pin to energize power module fan	9
PM_FAN1_0V	1 pin return for power module fan	45
PM_FAN2_BAT	1 pin to energize power module fan	33
PM_FAN2_0V	1 pin return for power module fan	46



A. The FSCB board is used to generate two different voltage reference (in order to change fans rotation speed) based on an Agate digital output connected on pin10
B. Voltage controller output signals (one for each fan) are on pin 14 and 17
C. Main voltage supply is connected on X21-9 and X21-33
D. Rotation status of each fan is acquired by the Agate via two digital inputs
E. The Agate in able to switch-on and switch-off the cooling fan trought K4 relay

4.4.2.3. Winscope / Traintracer TDB

Use **AutotestPMC.tdb** to support investigation.
Follow on-screen notes in order to:

- Start and stop cooling fan at low speed, verifying correct feedback
- Start and stop cooling fan at high speed, verifying correct feedback

4.4.3. Verifications - Failure 202

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Fan speed control board	**FSCB**
	LV contactor LC1D126BLS170	**K4**
	Power module fan (MF)	**M1PM, M2PM**

4.4.3.1. Message xx-29-13. PMC Fan DO for High Speed fault

AC3mini sets low/high speed fans to reduce noise when the vehicle is in standstill; this is done by the **FSCB** board (which set proper control voltage to the fans) controlled by an Agate DO. AC3mini itself is able to detect if the DO is unconnected, reading the current flow.

1 ***REPLACE*** **FSCB**
VERIFY fan rotation and correctness of the high-speed DO valid flag

2 ***CHECK*** cabling removing AC3mini
VERIFY that electrical connections are good

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY fan rotation and correctness of the high-speed DO valid flag

4.4.3.2. Message xx-29-14. PMC Fan1 UnableToStart or contactor Flt
4.4.3.3. Message xx-29-15. PMC Fan2 UnableToStart or contactor Flt

AC3mini controls **K4** (which energize both power module fans) and read rotation status feedback from each fan. **FSCB** board is used to select two motor speeds (low and high) based on a digital output command from the Agate.

1 ***CHECK*** that battery voltage is available on X21 pins

2 ***REPLACE*** **K4**
VERIFY fan rotation and related feedback status signal

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY fan rotation and correctness of the high-speed DO valid flag

4 ***REPLACE*** **FSCB**
VERIFY fan rotation and related feedback status signal

5 ***REPLACE*** **M1PM** or **M2PM** (depending on the fault message)
VERIFY fan rotation and related feedback status signal

4.4.4. Verifications - Failure 204

Involved LRUs		
TBCU	AGATE	**AC3mini**
	LV contactor LC1D126BLS170	**K4**
	Power module fan (MF)	**M1PM, M2PM**

4.4.4.1. Message xx-29-16. PMC Fan1 UnableToStop or contactor Stuck
4.4.4.2. Message xx-29-17. PMC Fan2 UnableToStop or contactor Stuck

AC3mini controls **K4** (which energize both power module fans) and read rotation status feedback from each fan. **FSCB** board is used to select two motor speeds (low and high) based on a digital output command from the Agate.

1 ***REPLACE*** **K4**
VERIFY fan rotation and related feedback status signal

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY fan rotation and correctness of the high-speed DO valid flag

3 ***REPLACE*** **M1PM** or **M2PM** (depending on the fault message)
VERIFY fan rotation and related feedback status signal

4.5. Autotest – PowerModule Protections

4.5.1. Description

This sequence check proper functionalities of the diagnostic information coming from gate drives and thermo switches, producing a specific diagnostic message in case of fault condition.

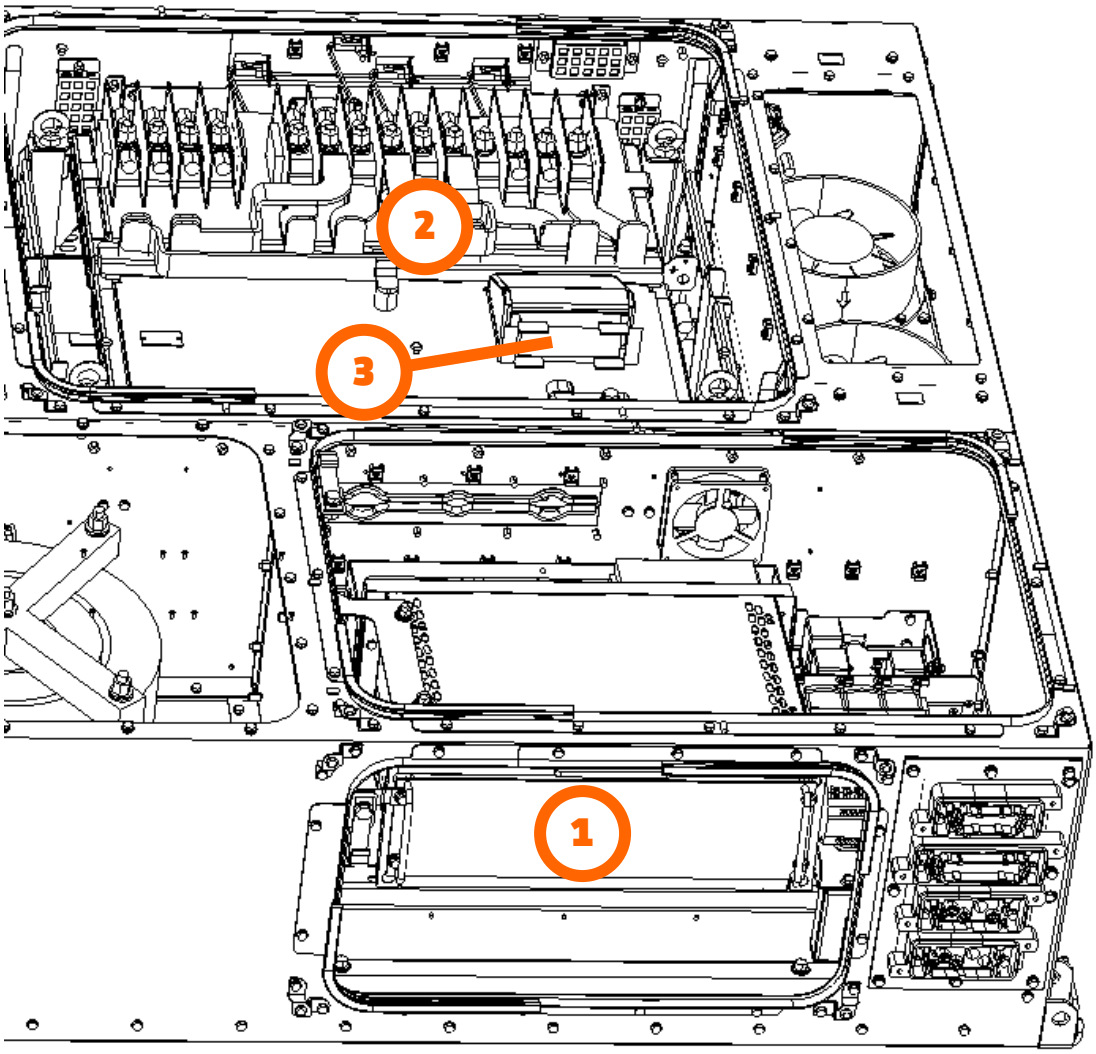
Step	Test	TrainTracerCode
-	PowerModule Protections test sequence starts	xx-29-24
301	If inverter1 Gate Unit is in fault trigger an error and stop test	xx-29-26
	If braking chopper1 Gate Unit is in fault trigger an error and stop test	xx-29-27
	If inverter2 Gate Unit is in fault trigger an error and stop test	xx-29-28
	If braking chopper2 Gate Unit is in fault trigger an error and stop test	xx-29-29
302	If thermoswitch inverter1 detect overtemperature trigger an error and stop test	xx-29-2A
	If thermoswitch inverter2 detect overtemperature trigger an error and stop test	xx-29-2B
-	PowerModule Protections test sequence complete	xx-29-25

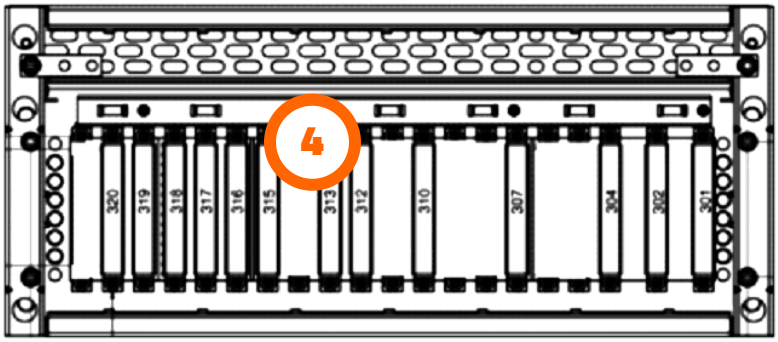
The following messages will trace in the diagnostic memory the test steps.

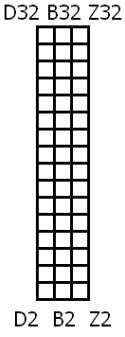
TrainTracerCode	Stack	Text message
xx-29-24	Message	Start test Power Module Protection
xx-29-25	Message	End test Power Module Protection
xx-29-26	Message	GU inverter1 not OK
xx-29-27	Message	GU Braking chopper inverter1 not OK
xx-29-28	Message	GU inverter2 not OK
xx-29-29	Message	GU Braking chopper inverter2 not OK
xx-29-2A	Message	Thermoswitch inverter1 not OK
xx-29-2B	Message	Thermoswitch inverter2 not OK

4.5.2. Involved LRUs

4.5.2.1. TBCU

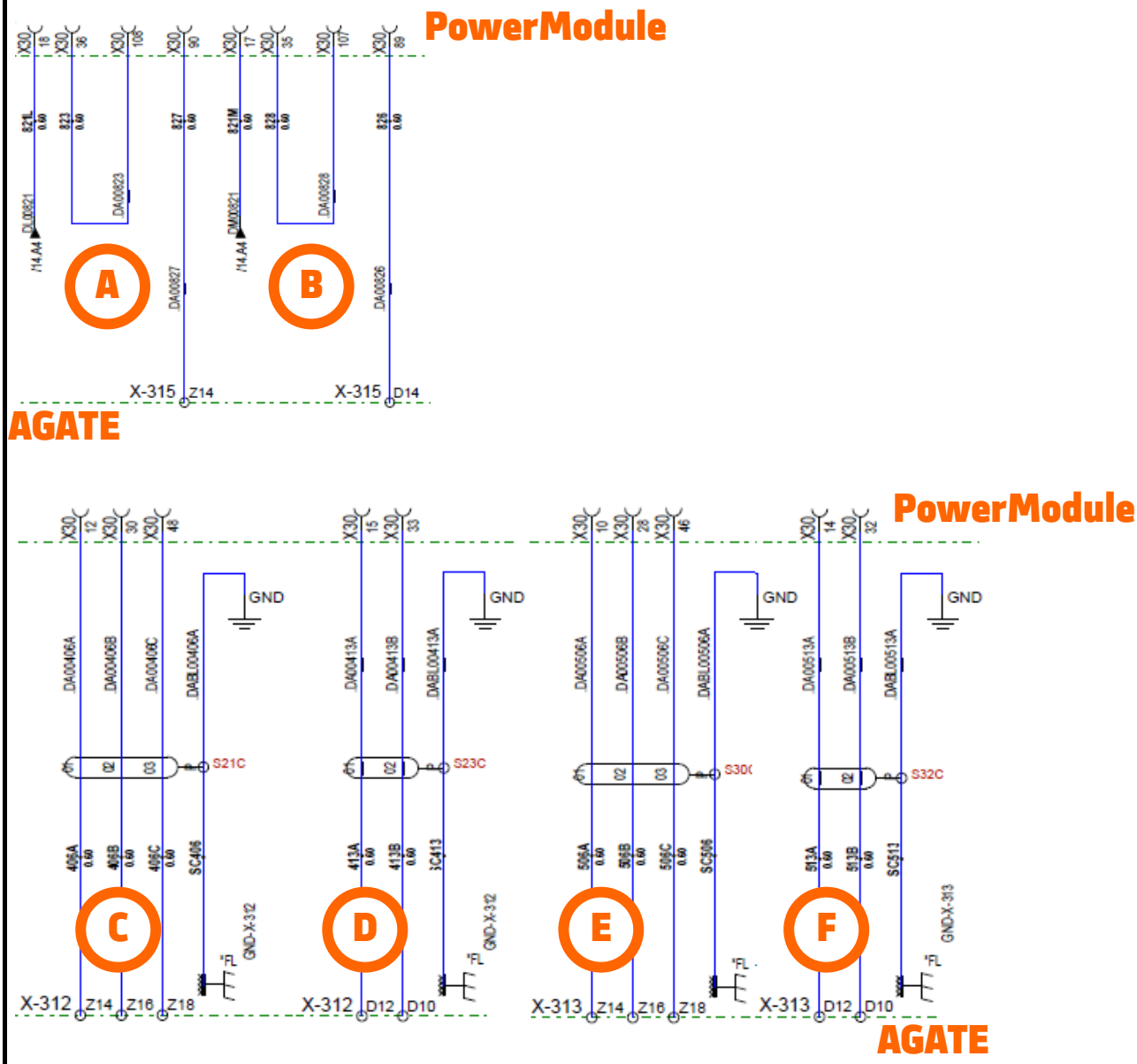






POS	Description	
1	AGATE	**AC3mini**
2	Power module ONIX850DLP3	**ONIX850DLP3**
3	Power module BT connector	**X30**
4	AGATE backplane layout	

4.5.2.2. TBCU LV Scheme



A. Two thermoswitches related to inverter1 are connected in series and acquired by an Agate digital input
B. Two thermoswitches related to inverter2 are connected in series and acquired by an Agate digital input
C. Gate drive status from Inverter1
D. Gate drive status from Chopper1
E. Gate drive status from Inverter2
F. Gate drive status from Chopper2

4.5.2.3. Winscope / Traintracer TDB

Use **AutotestPMP.tdb** to support investigation.
Follow on-screen notes in order to:

- Check correct feedback from Gate Drive inverter1
- Check correct feedback from Gate Drive chopper1
- Check correct feedback from Gate Drive inverter2
- Check correct feedback from Gate Drive chopper2
- Check correct feedback from thermoswitches inverter1
- Check correct feedback from thermoswitches inverter2

4.5.3. Verifications - Failure 301

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Power module ONIX850DLP3	**ONIX850DLP3**

4.5.3.1. Message xx-29-26. GU inverter1 not OK
4.5.3.2. Message xx-29-27. GU Braking chopper inverter1 not OK

AC3mini read feedback status from gate units board (inside the power module) which control and monitor IGBTs.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY Gate unit diagnostic feedbacks

2 ***CHECK*** the cabling between the rack and the power module LV connector removing the Agate
VERIFY that electrical connections are good

3 ***REPLACE*** **ONIX850DLP3**

4.5.3.3. Message xx-29-28. GU inverter2 not OK
4.5.3.4. Message xx-29-29. GU Braking chopper inverter2 not OK

AC3mini read feedback status from gate units board (inside the power module) which control and monitor IGBTs.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY Gate unit diagnostic feedbacks

2 ***CHECK*** the cabling between the rack and the power module LV connector removing the Agate
VERIFY that electrical connections are good

3 ***REPLACE*** **ONIX850DLP3**

4.5.4. Verifications - Failure 302

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Power module ONIX850DLP3	**ONIX850DLP3**

4.5.4.1. Message xx-29-2A. Thermoswitch inverter1 not OK
4.5.4.2. Message xx-29-2B. Thermoswitch inverter2 not OK

AC3mini detects overtemperature faults reading status from specific thermoswitches mounted on the power module heat sink.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY thermoswitches status signals

2 ***CHECK*** the cabling between the rack and the power module LV connector removing the Agate
VERIFY that electrical connections are good

3 ***REPLACE*** **ONIX850DLP3**

4.6. Autotest – PowerModule Transducers

4.6.1. Description

This sequence check correctness information coming from current and voltage sensors (when inverter pulses are switched-off and no voltage on DC link is present thanks to the open line contactor), producing a specific diagnostic message in case of fault condition.

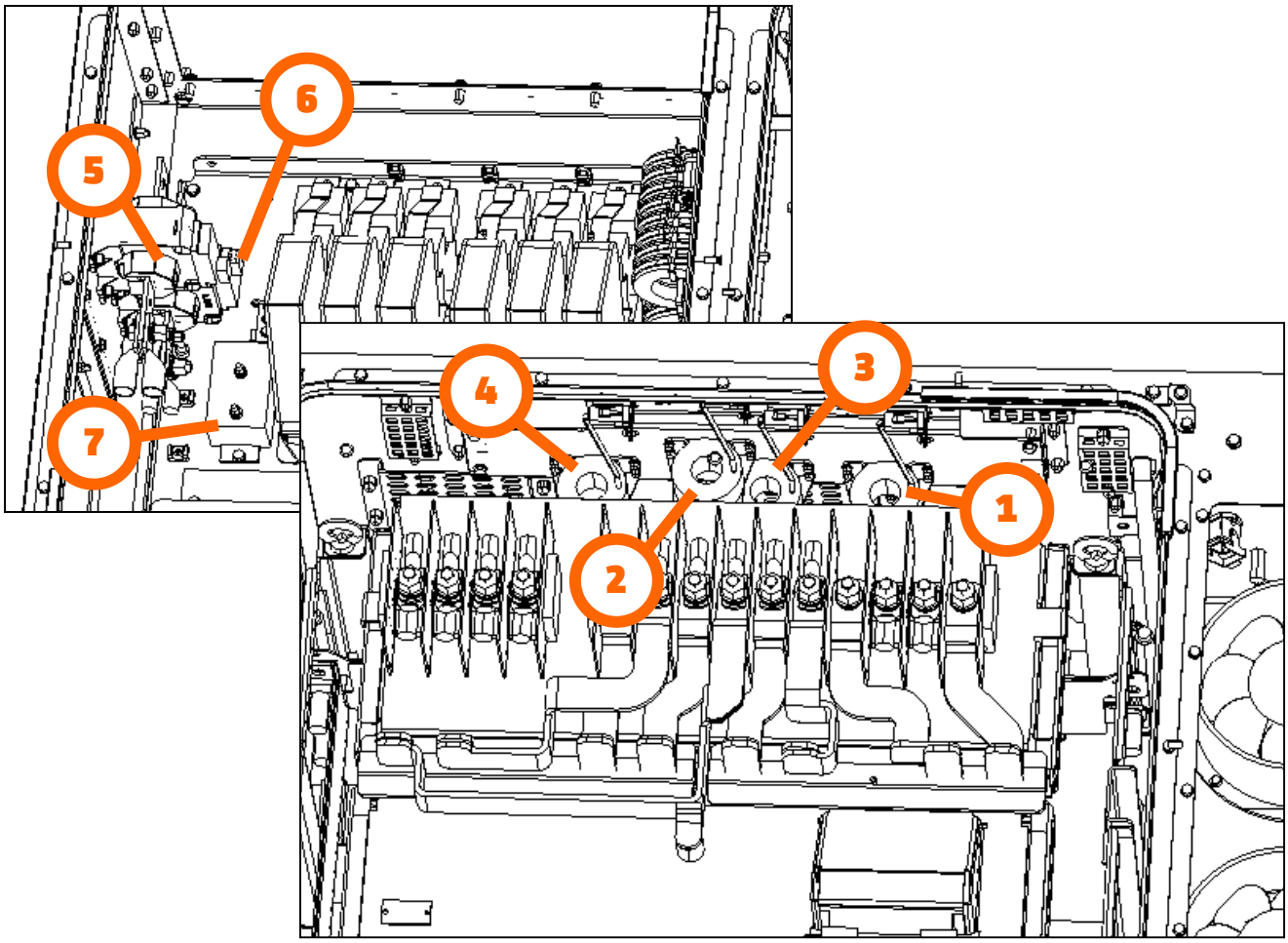
Step	Test	TrainTracerCode
-	PowerModule Transducers test sequence starts	xx-29-2C
401	If M1R current sensor measured value is above a threshold, trigger an error and stop test	xx-29-30
	If M1S current sensor measured value is above a threshold, trigger an error and stop test	xx-29-31
	If M2R current sensor measured value is above a threshold, trigger an error and stop test	xx-29-32
	If M2S current sensor measured value is above a threshold, trigger an error and stop test	xx-29-33
402	If DCCurrPos sensor measured value is above a threshold, trigger an error and stop test	xx-29-2E
	If DCCurrNeg sensor measured value is above a threshold, trigger an error and stop test	xx-29-2F
403	If DCVoltage sensor measured value is above a threshold, trigger an error and stop test	xx-29-34
-	PowerModule Transducers test sequence complete	xx-29-2D

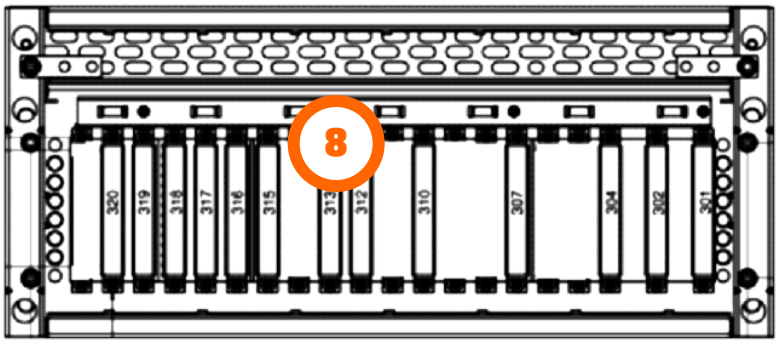
The following messages will trace in the diagnostic memory the test steps.

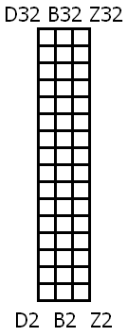
TrainTracerCode	Stack	Text message
xx-29-2C	Message	`Start test Power Module Transducers`
xx-29-2D	Message	`End test Power Module Transducers`
xx-29-2E	Message	`Current sensor DC positive offset fault`
xx-29-2F	Message	`Current sensor DC negative offset fault`
xx-29-30	Message	`Current sensor Motor1 phaseR offset flt`
xx-29-31	Message	`Current sensor Motor1 phaseS offset flt`
xx-29-32	Message	`Current sensor Motor2 phaseR offset flt`
xx-29-33	Message	`Current sensor Motor2 phaseS offset flt`
xx-29-34	Message	`Voltage sensor DC Bus offset fault`

4.6.2. Involved LRUs

4.6.2.1. TBCU

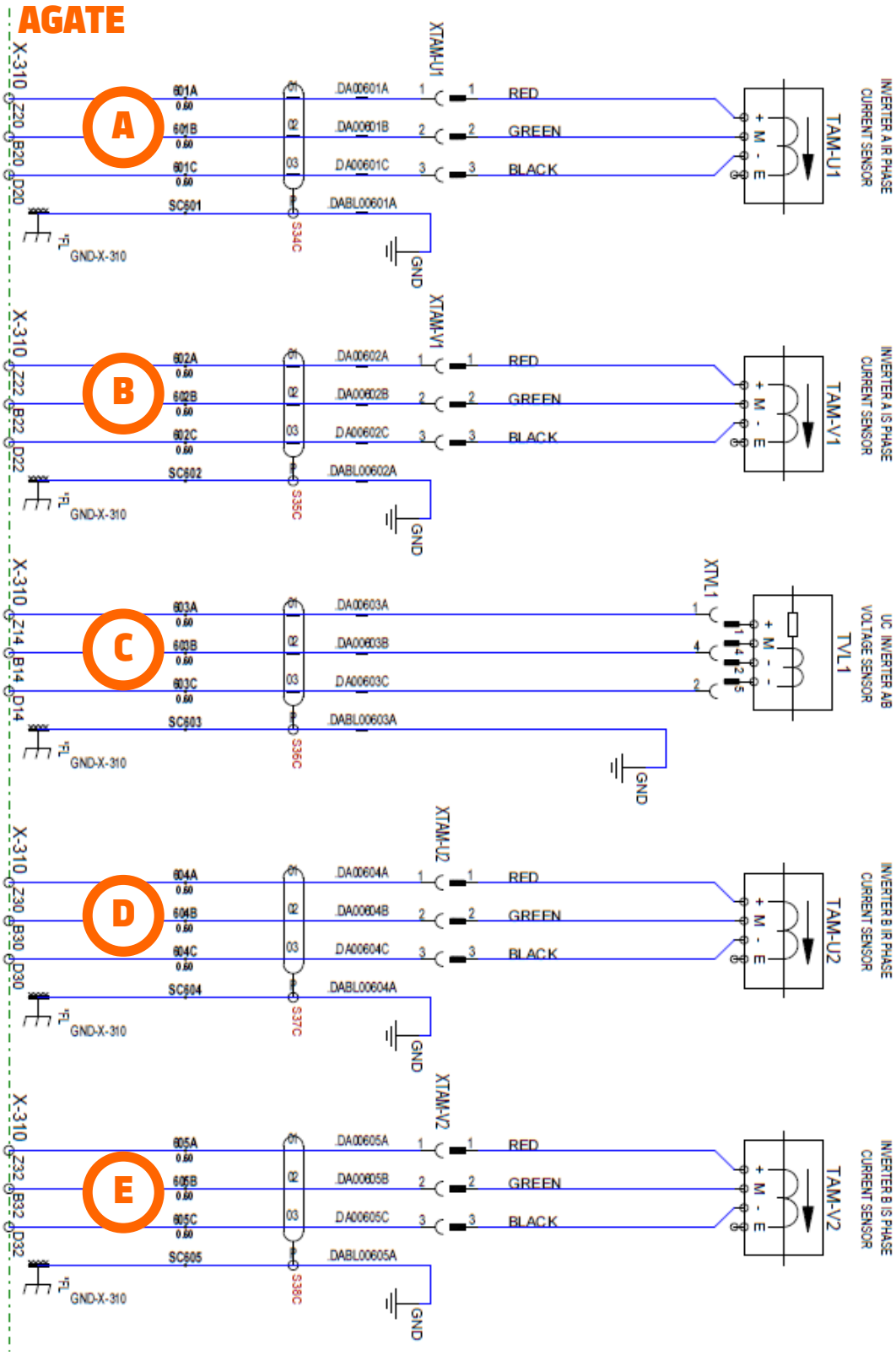




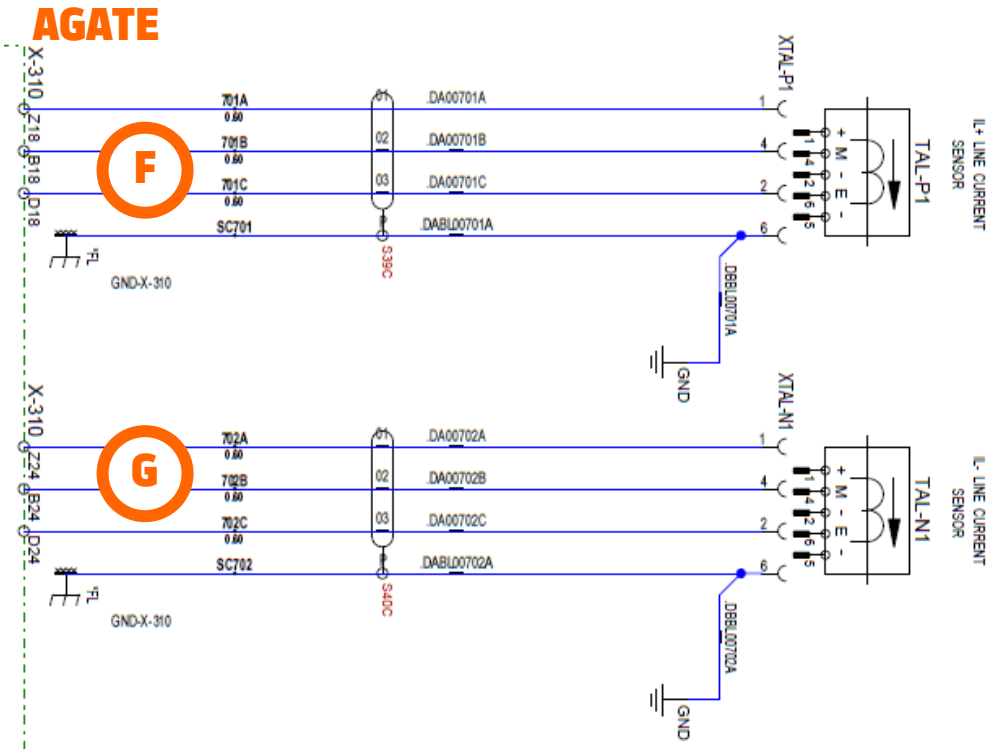


POS	Description	
1	Motor phase current sensor	**TAM_U1**
2	Motor phase current sensor	**TAM_V1**
3	Motor phase current sensor	**TAM_U2**
4	Motor phase current sensor	**TAM_V2**
5	Line current sensor	**TAL_P1**
6	Line current sensor	**TAL_N1**
7	Line voltage sensor	**TVL1**
8	AGATE backplane layout	

4.6.2.2. TBCU LV Scheme



A. Motor1 phaseR standard current sensor (Hall-effect) is directly acquired by the Agate
B. Motor1 phaseS standard current sensor (Hall-effect) is directly acquired by the Agate
C. DC voltage transducer is directly acquired by the Agate
D. Motor2 phaseR standard current sensor (Hall-effect) is directly acquired by the Agate
E. Motor2 phaseS standard current sensor (Hall-effect) is directly acquired by the Agate



F. DC current (positive) standard current sensor (Hall-effect) is directly acquired by the Agate
G. DC current (negative) standard current sensor (Hall-effect) is directly acquired by the Agate

4.6.2.3. Winscope / Traintracer TDB

Use **AutotestPMT.tdb** to support investigation.
Follow on-screen notes in order to:

- Verify measured motor1 phase currents
- Verify measured motor2 phase currents
- Verify measured positive DC current
- Verify measured negative DC current
- Verify measured DC bus voltage

4.6.3. Verifications - Failure 401

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Motor phase current sensor LF505-S/SP28	**TAM_U1, TAM_V1, TAM_U2, TAM_V2**

4.6.3.1. Message xx-29-30. Current sensor Motor1 phaseR offset flt
4.6.3.2. Message xx-29-31. Current sensor Motor1 phaseS offset flt

AC3mini uses voltage and current transducers for inverter protection and motors control.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that motor1 currents value are around zero

2 ***CHECK*** cabling between Agate rack connectors and the measuring device removing AC3mini
VERIFY that electrical connections are good

3 ***REPLACE*** **TAM_U1** or **TAM_V1** depending on the diagnostic message (phaseR is U1, phases is V1)
VERIFY that motor1 currents value are around zero

4.6.3.3. Message xx-29-32. Current sensor Motor2 phaseR offset flt
4.6.3.4. Message xx-29-33. Current sensor Motor2 phaseS offset flt

AC3mini uses voltage and current transducers for inverter protection and motors control.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that motor2 currents value are around zero

2 ***CHECK*** cabling between Agate rack connectors and the measuring device removing AC3mini
VERIFY that electrical connections are good

3 ***REPLACE*** **TAM_U2** or **TAM_V2** depending on the diagnostic message (phaseR is U1, phases is V1)
VERIFY that motor2 currents value are around zero

4.6.4. Verifications - Failure 402

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Line current sensor 1000A 250mA	**TAL_P1, TAL_N1**

4.6.4.1. Message xx-29-2E. Current sensor DC positive offset fault
4.6.4.2. Message xx-29-2F. Current sensor DC negative offset fault

AC3mini uses voltage and current transducers for inverter protection and motors control.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that DC currents value are around zero

2 ***CHECK*** cabling between Agate rack connectors and the measuring device removing AC3mini
VERIFY that electrical connections are good

3 ***REPLACE*** **TAM_P1** or **TAM_N1** depending on the diagnostic message (DCPositive is P1, DCNegative is N1)
VERIFY that DC currents value are around zero

4.6.5. Verifications - Failure 403

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Line voltage sensor AV100-1000/SP2	**TVL1**

4.6.5.1. Message xx-29-34. Voltage sensor DC Bus offset fault

AC3mini uses voltage and current transducers for inverter protection and motors control.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that DC voltage value is around zero

2 ***CHECK*** cabling between Agate rack connectors and the measuring device removing AC3mini
VERIFY that electrical connections are good

3 ***REPLACE*** **TVL1**
VERIFY that DC voltage value is around zero

4.7. Autotest – Speed Transducers

4.7.1. Description

This sequence check correctness information coming from speed – position sensors, producing a specific diagnostic message in case of fault condition.

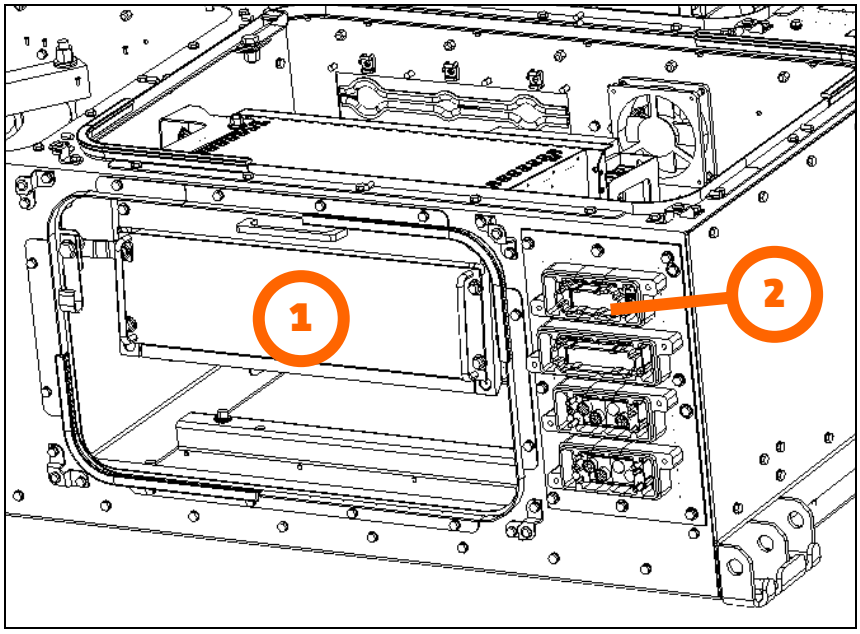
Step	Test	TrainTracerCode
-	Speed transducers test sequence starts	xx-29-18
501	If speed sensor channel 1 is in fault, trigger an error and stop test	xx-29-1A
	If speed sensor channel 2 is in fault, trigger an error and stop test	xx-29-1B
	If speed sensor channel 3 is in fault, trigger an error and stop test	xx-29-1C
	If speed sensor channel 4 is in fault, trigger an error and stop test	xx-29-1D
	If speed sensor channel 5 is in fault, trigger an error and stop test	xx-29-1E
	If speed sensor channel 6 is in fault, trigger an error and stop test	xx-29-1F
-	Speed transducers test sequence complete	xx-29-19

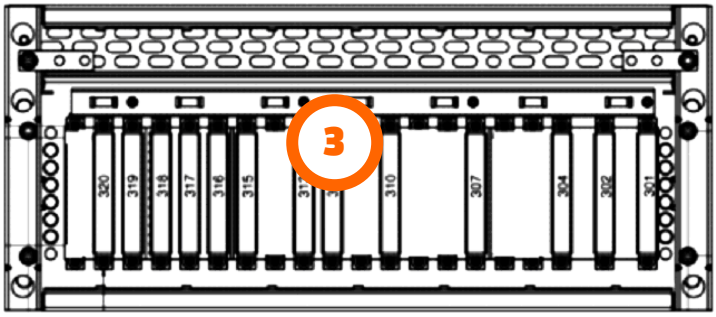
The following messages will trace in the diagnostic memory the test steps.

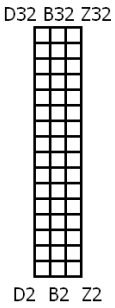
TrainTracerCode	Stack	Text message
xx-29-18	Message	Start test Speed Transducers
xx-29-19	Message	End test Speed Transducers
xx-29-1A	Message	Speed channel 1 Fault
xx-29-1B	Message	Speed channel 2 Fault
xx-29-1C	Message	Speed channel 3 Fault
xx-29-1D	Message	Speed channel 4 Fault
xx-29-1E	Message	Speed channel 5 Fault
xx-29-1F	Message	Speed channel 6 Fault

4.7.2. Involved LRUs

4.7.2.1. TBCU

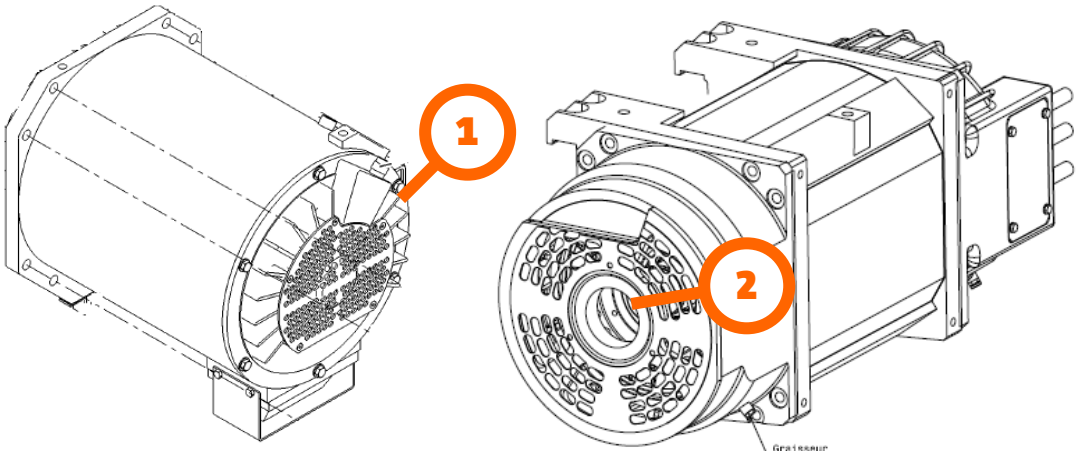






POS	Description	
1	AGATE	**AC3mini**
2	BT connector	**X20**
3	AGATE backplane layout	

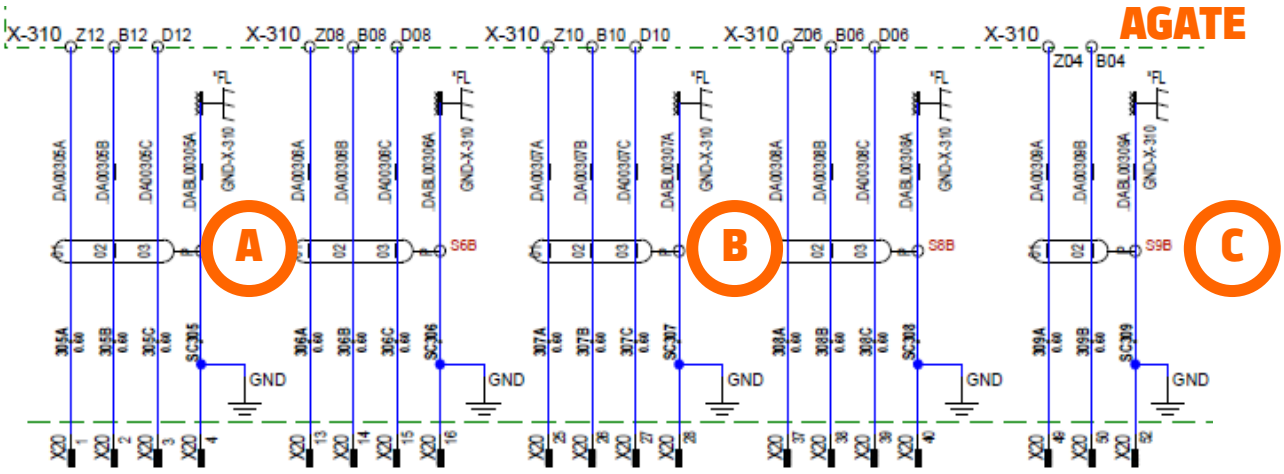
4.7.2.2. Motors



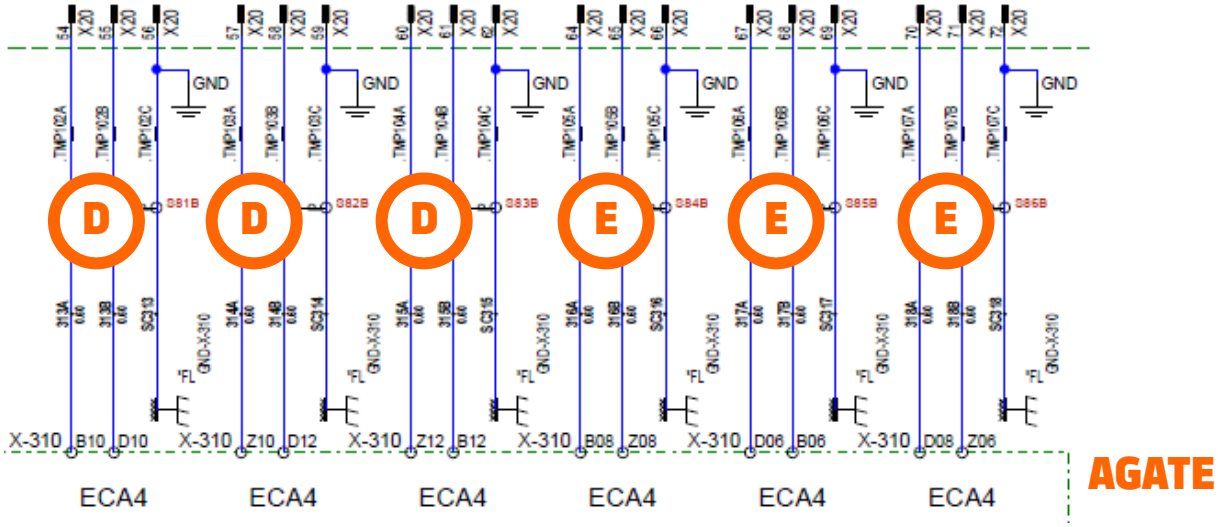
POS	Description	
1	MAS motor Speed sensor - RH1522	
2	Synchro-resolver	

4.7.2.3. TBCU LV Scheme

Name	Description	X20 Pinout
MAS1 SP1	3wire (+shield) speed sensor installed on motor 1	1,2,3,4 (15V,IN,GND,Sh)
MAS1 SP2	3wire (+shield) speed sensor installed on motor 1	25,26,27,28 (15V,IN,GND,Sh)
MAS2 SP1	3wire (+shield) speed sensor installed on motor 2	13,14,15,16 (15V,IN,GND,Sh)
MAS2 SP2	3wire (+shield) speed sensor installed on motor 2	37,38,39,40 (15V,IN,GND,Sh)
AXLEADD1	2wire (+shield) speed sensor installed on a trailed axle for additional speed information	49,50,52 (15V,IN,Sh)



Name	Description	X20 Pinout
PMM1	6wire (+shield) resolver installed on motor 1	54,55,56 (RefH,RefL,Sh) 57,58,59 (CosH,CosL,Sh) 60,61,62 (SinH,SinL,Sh)
PMM2	6wire (+shield) resolver installed on motor 2	64,65,66 (RefH,RefL,Sh) 67,68,69 (CosH,CosL,Sh) 70,71,72 (SinH,SinL,Sh)



A. MAS configuration : speed sensors related to motor1 (two single channel sensor)
B. MAS configuration : speed sensors related to motor2 (two single channel sensor)
C. MAS and PMM configuration : speed sensor from trailer bogie
D. PMM configuration : syncro-resolver relater to motor1
E. PMM configuration : syncro-resolver relater to motor2

4.7.2.4. Winscope / Traintracer TDB

Use **AutotestSST.tdb** to support investigation.
Follow on-screen notes in order to:

- check diagnostic flags related to motor1 speed sensors
- check diagnostic flags related to motor2 speed sensors
- check diagnostic flags related to trailer axle speed sensor

4.7.3. Verifications - Failure 501

Involved LRUs		
TBCU	AGATE	**AC3mini**
Motorized bogie	Speed sensor	**-**
	Synchro-resolver	**-**
Trailer bogie	Speed sensor	**-**

4.7.3.1. Message xx-29-1A. Speed channel 1 Fault
4.7.3.2. Message xx-29-1B. Speed channel 2 Fault
4.7.3.3. Message xx-29-1C. Speed channel 3 Fault
4.7.3.4. Message xx-29-1D. Speed channel 4 Fault
4.7.3.5. Message xx-29-1E. Speed channel 5 Fault
4.7.3.6. Message xx-29-1F. Speed channel 6 Fault

AC3mini is able to verify correctness of the electric signal coming from each speed and/or resolver transducer.
Take into account the following notes :

- Speed channel **1** and **2** are related to **motor1**
- Speed channel **3** and **4** are related to **motor2**
- Speed channel **5** is related to **trailer** axle

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that diagnostic information from sensors are correct (no faults anymore)

2 ***CHECK*** the cabling between the rack and the speed sensor connector removing the Agate
VERIFY that electrical connections are good

3 ***REPLACE*** the broken speed sensor
VERIFY that diagnostic information from sensors are correct (no faults anymore)

The TSP Troubleshooting Guide [R4] provided detailed information regarding speed sensors fault detection.

4.8. Low Power Test – Precharge and motor contactors

4.8.1. Description

This sequence tests the correct behaviour of the precharge circuit (with high voltage), motor contactors (in case of PMM Traction configuration), and braking choppers.
In details, the following tests are performed :

- o check proper functionalities of the contactors using the information from the related aux contact
- o check proper charge phase of the HV circuit
- o control braking chopper with a fixed dutycycle and verify correct DC current measurements from transducers

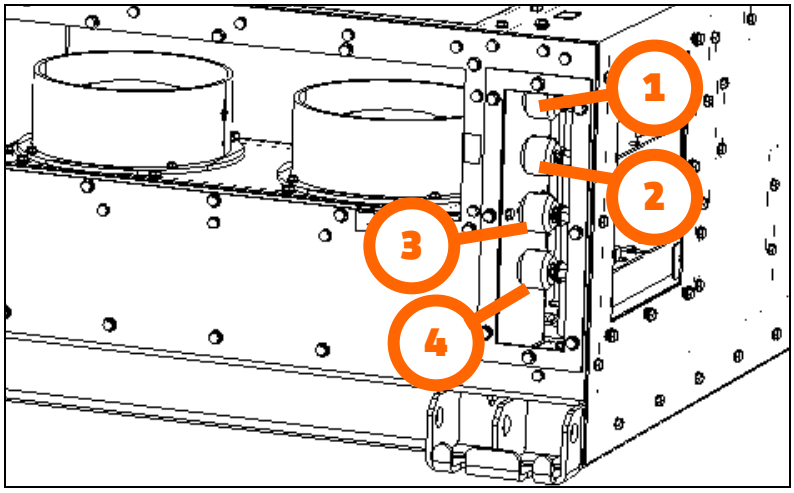
Step	Test	TrainTracerCode
-	Contactors test sequence starts	xx-29-35
601	Close precharge contactor	-
602	If DCVoltage<threshold AND precharge aux contact=False, trigger an error and stop test	xx-29-37
	If DCVoltage<threshold AND precharge aux contact=True, trigger an error and stop test	xx-29-38
	If DCVoltage>threshold, close line contactor	-
603	Open precharge contactor	-
	If line aux contact=False, trigger an error and stop test	xx-29-39
	If line aux contact=True, precharge phase is correct	xx-29-3A
604	Inhibit braking chopper2 and set braking chopper1 dutycycle to a fixed value	-
605	If measured DCCurrPos is out of the expected range, trigger an error and stop test	xx-29-3B
	If measured DCCurrNeg is out of the expected range, trigger an error and stop test	xx-29-3C
606	Switch-off chopper1 and remove inhibition chopper2	-
607	Inhibit braking chopper1 and set braking chopper2 dutycycle to a fixed value	-
608	If measured DCCurrPos is out of the expected range, trigger an error and stop test	xx-29-3D
	If measured DCCurrNeg is out of the expected range, trigger an error and stop test	xx-29-3E
609	Switch-off chopper2 and remove inhibition chopper1	-
610	Close M1 contactor and M2 contactor	-
611	If M1 contactor aux contact=false, trigger an error and stop test	xx-29-20
	If M2 contactor aux contact=false, trigger an error and stop test	xx-29-22
612	Open M1 and M2 contactors	-
613	If M1 contactor aux contact=true, trigger an error and stop test	xx-29-21
	If M2 contactor aux contact=true, trigger an error and stop test	xx-29-23
614	Close again M1 and M2 contactors	-
-	Contactors test sequence complete	xx-29-36

The following messages will trace in the diagnostic memory the test steps.

TrainTracerCode	Stack	Text message
xx-29-35	Message	Start Low Power Test precharge
xx-29-36	Message	End Low Power Test precharge
xx-29-37	Message	Precharge contactor doesn't close
xx-29-38	Message	Short circuit during precharge
xx-29-39	Message	Line contactor doesn't close
xx-29-3A	Message	Precharge phase completed
xx-29-3B	Message	Braking chopper1 KO or DC PosCurr Fault
xx-29-3C	Message	Braking chopper1 KO or DC NegCurr Fault
xx-29-3D	Message	Braking chopper2 KO or DC PosCurr Fault
xx-29-3E	Message	Braking chopper2 KO or DC NegCurr Fault
xx-29-20	Message	Motor Contactor1 unable to close
xx-29-21	Message	Motor Contactor1 fault during open
xx-29-22	Message	Motor Contactor2 unable to close
xx-29-23	Message	Motor Contactor2 fault during open

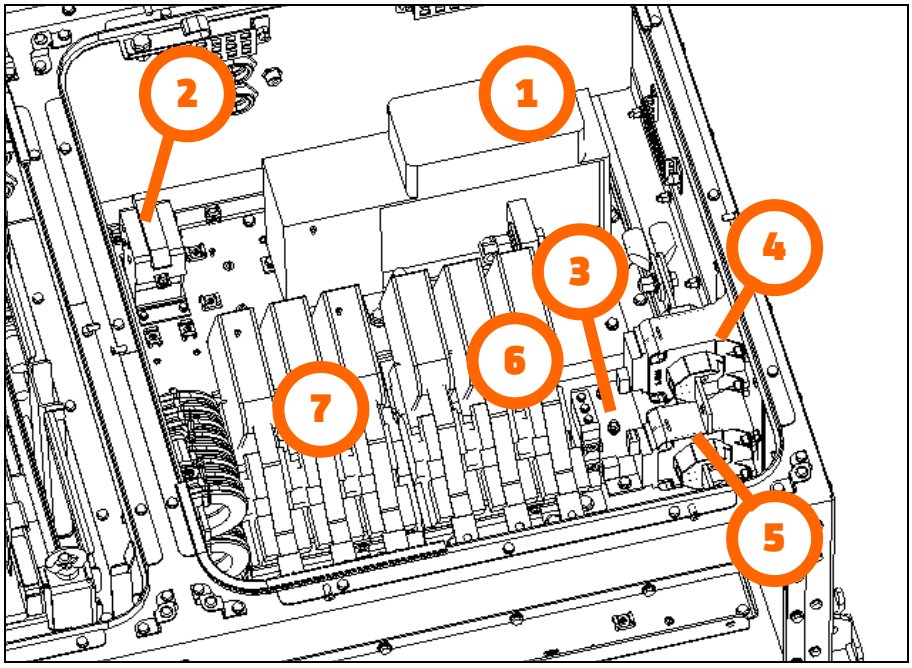
4.8.2. Involved LRUs

4.8.2.1. Braking Rheostat

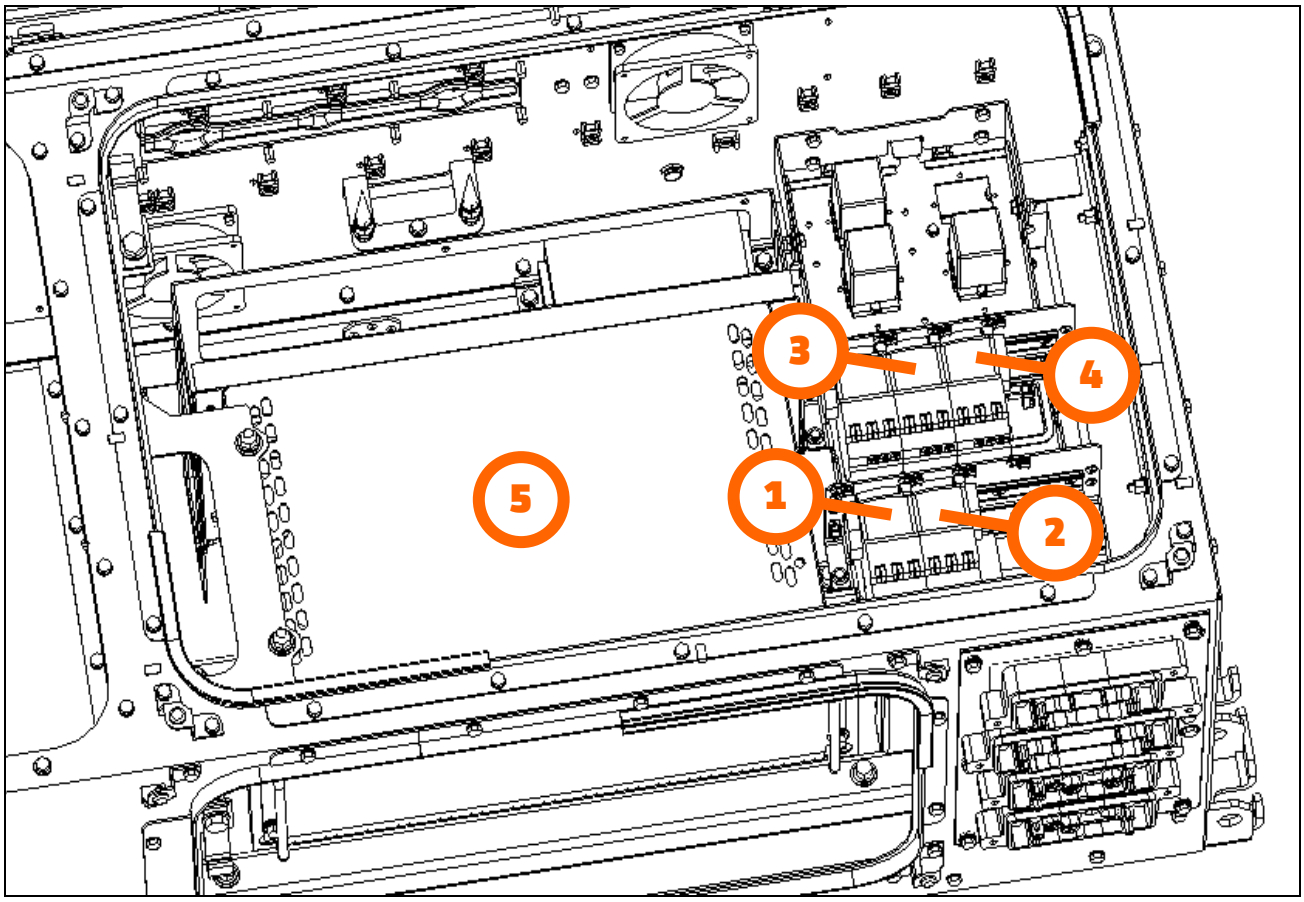


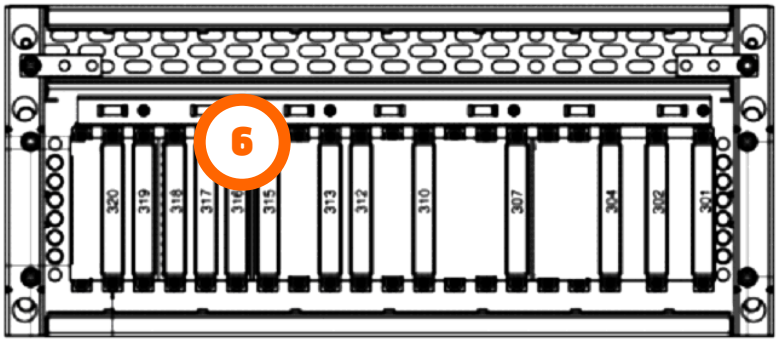
POS	Description	
1	Braking rheostat 1	**RH1+**
2	Braking rheostat 1	**RH1-**
3	Braking rheostat 2	**RH2+**
4	Braking rheostat 2	**RH2-**

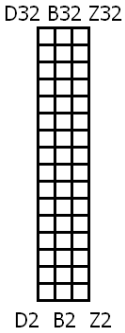
4.8.2.2. TBCU



POS	Description	
1	Line contactor Sécheron	**KL1**
2	Precharge contactor LTC100	**KPRE1**
3	Line voltage sensor AV100-1000/SP2	**TVL1**
4	Line current sensor	**TAL_P1**
5	Line current sensor	**TAL_N1**
6	Three pole motor contactor LTHS0320HFO0	**KMOT1**
7	Three pole motor contactor LTHS0320HFO0	**KMOT2**

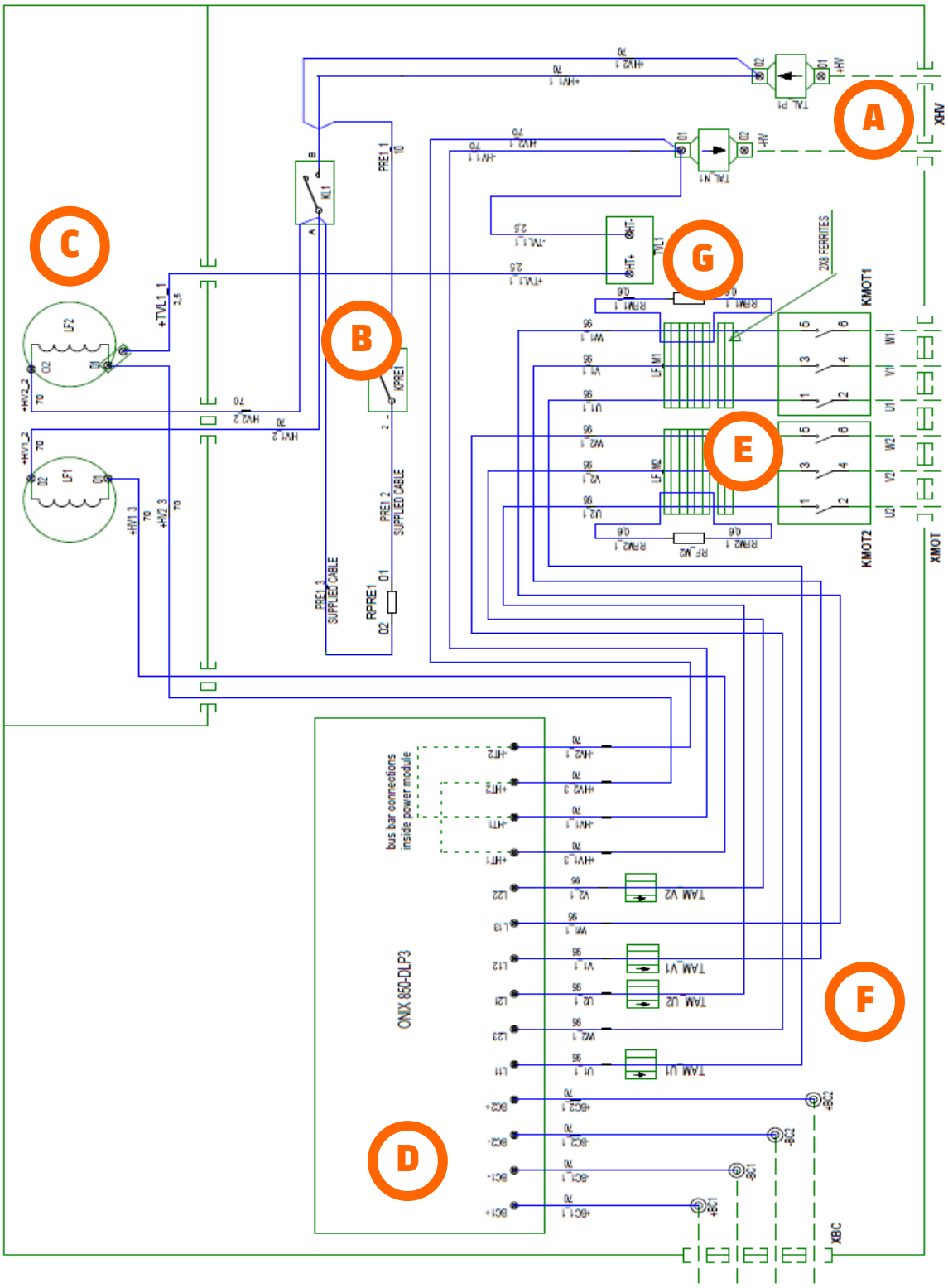






POS	Description	
1	LV contactor LC1D126BLS170	**K10**
2	LV contactor LC1D126BLS170	**K11**
3	LV contactor LC1D126BLS170	**K5**
4	LV contactor LC1D126BLS170	**K6**
5	AGATE	**AC3mini**
6	AGATE backplane layout	

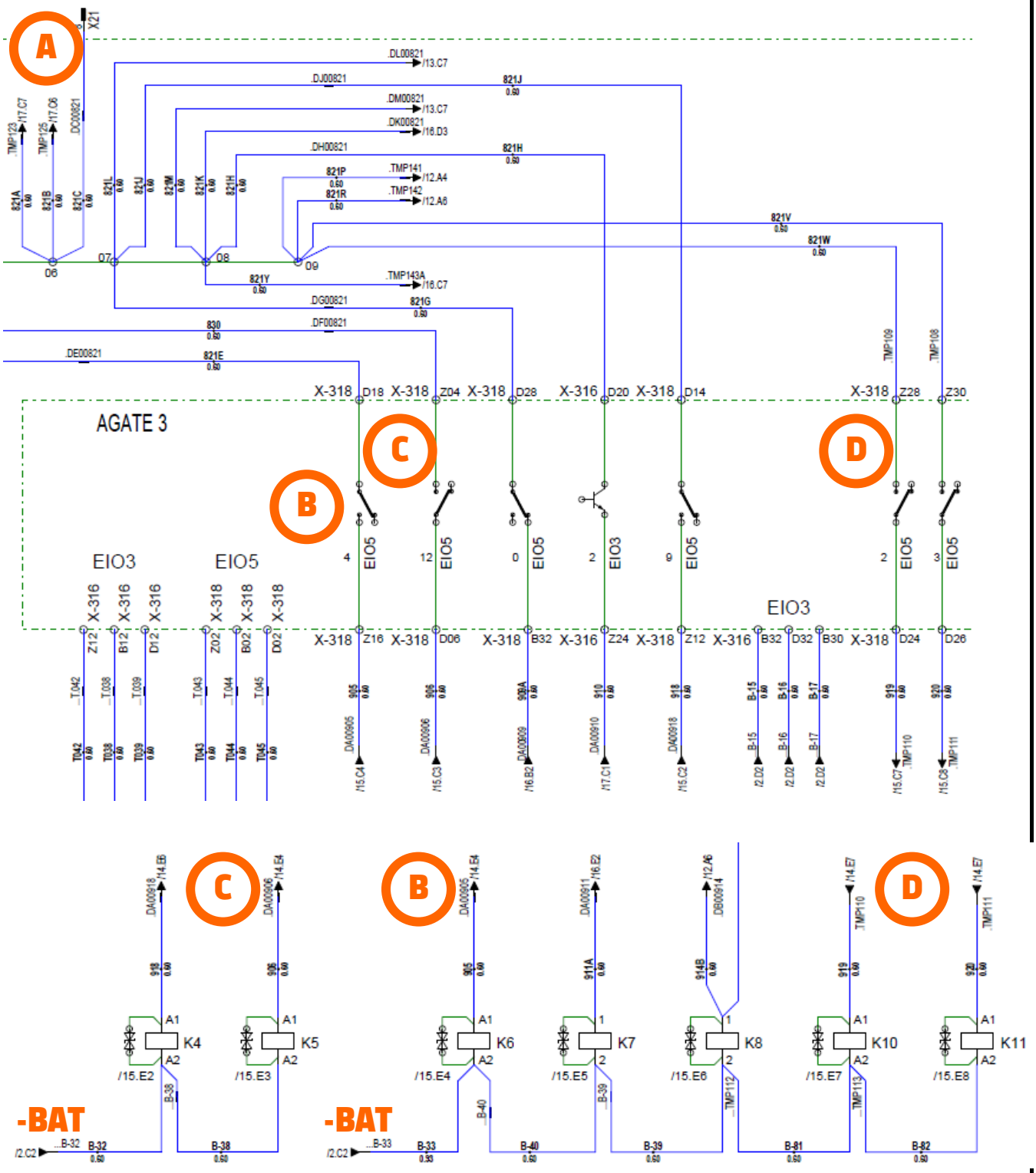
4.8.2.3. TBCU HV Scheme



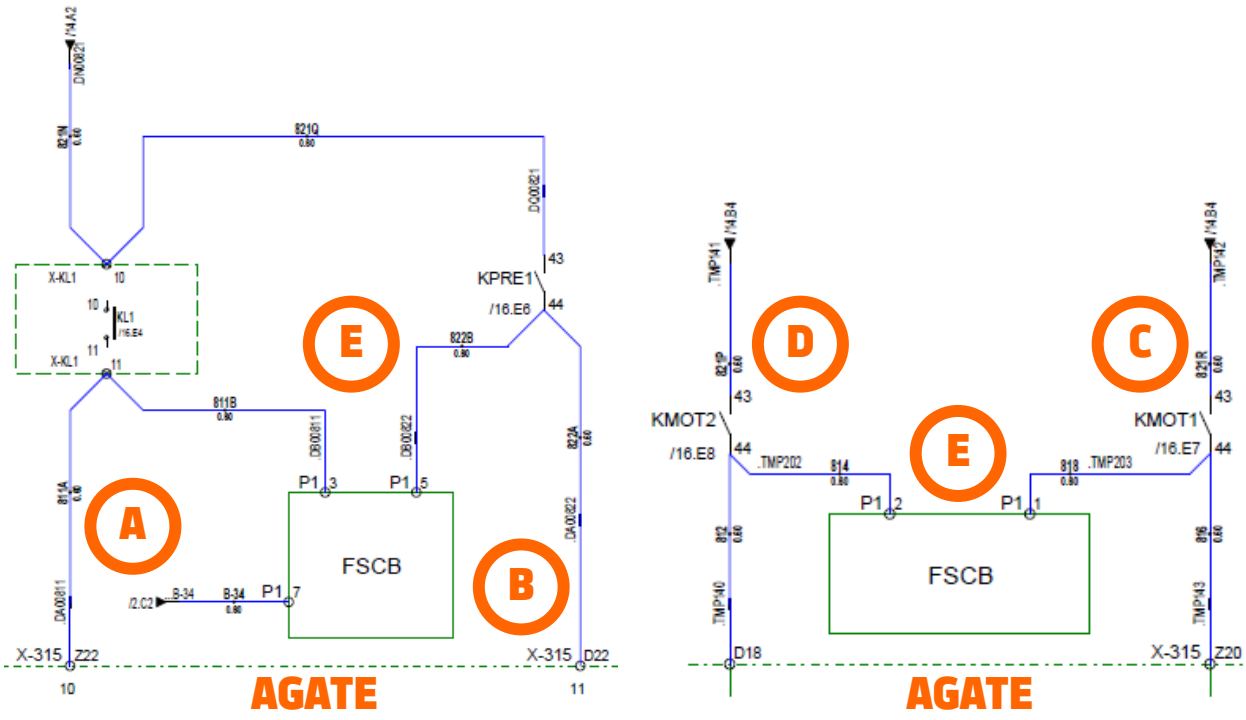
A. Incoming DC line from HSCB
B. Line and precharge contactors
C. Inductors (connected in parallel thanks to a bus bar inside the power module)
D. Power Module ONIX 850DLP3
E. PMM configuration only : motor contactors
F. Current transducers for motors phases
G. DC voltage transducer

4.8.2.4. TBCU LV Scheme

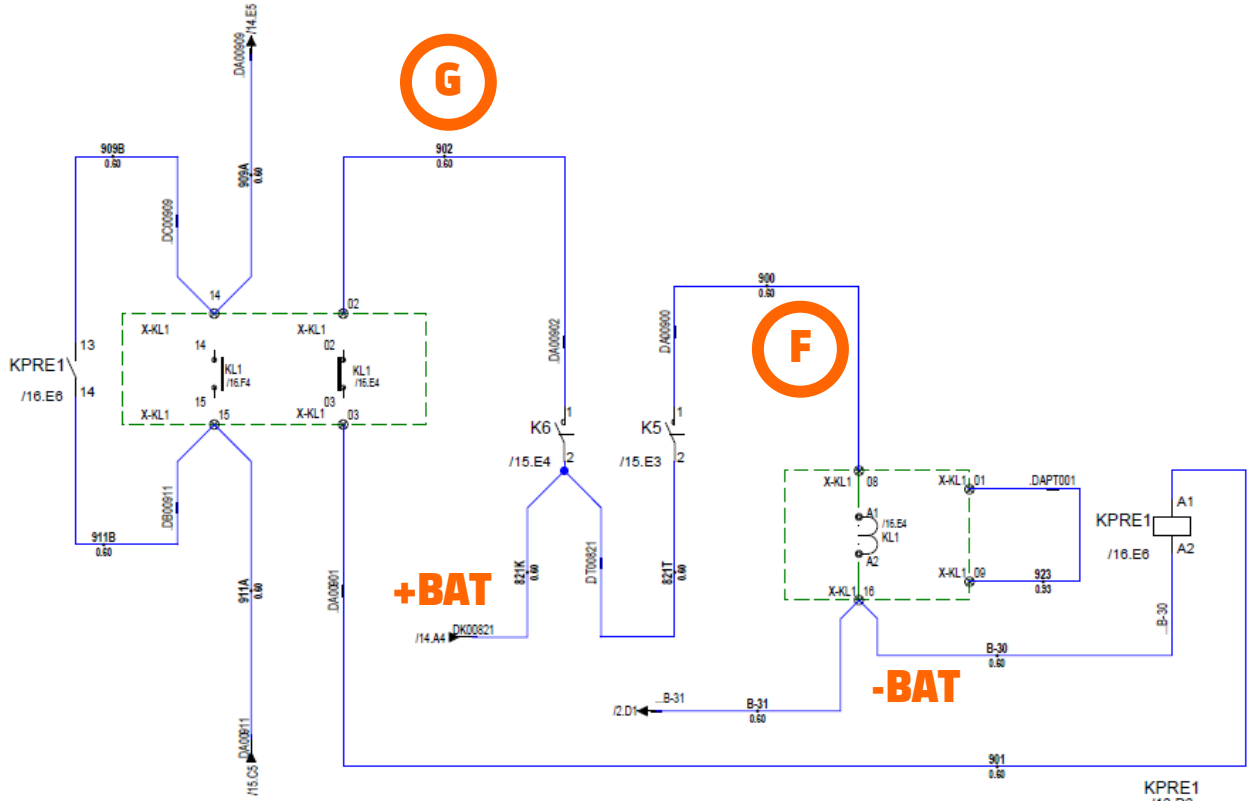
Name	Description	X21
LV_BAT_IN	pin to energize internal LV devices (contactors, relays ...)	8



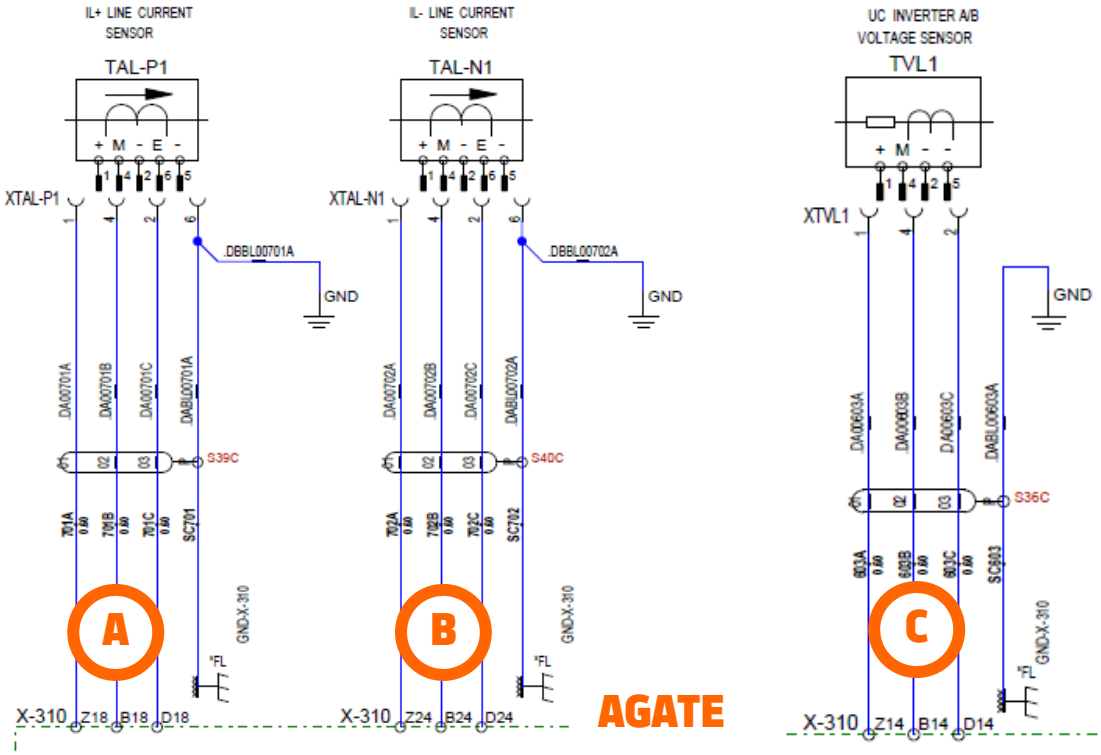
A. Battery voltage to energize internal relays and contactors comes from X21-8
B. Agate controls K6 relay , which energize precharge contactor KPRE coil
C. Agate controls K5 relay, which energize line contactor KL1 coil
D. Agate controls K10 and K11 relays, that energize main motor contactor (KMOT1 and KMOT2) coils



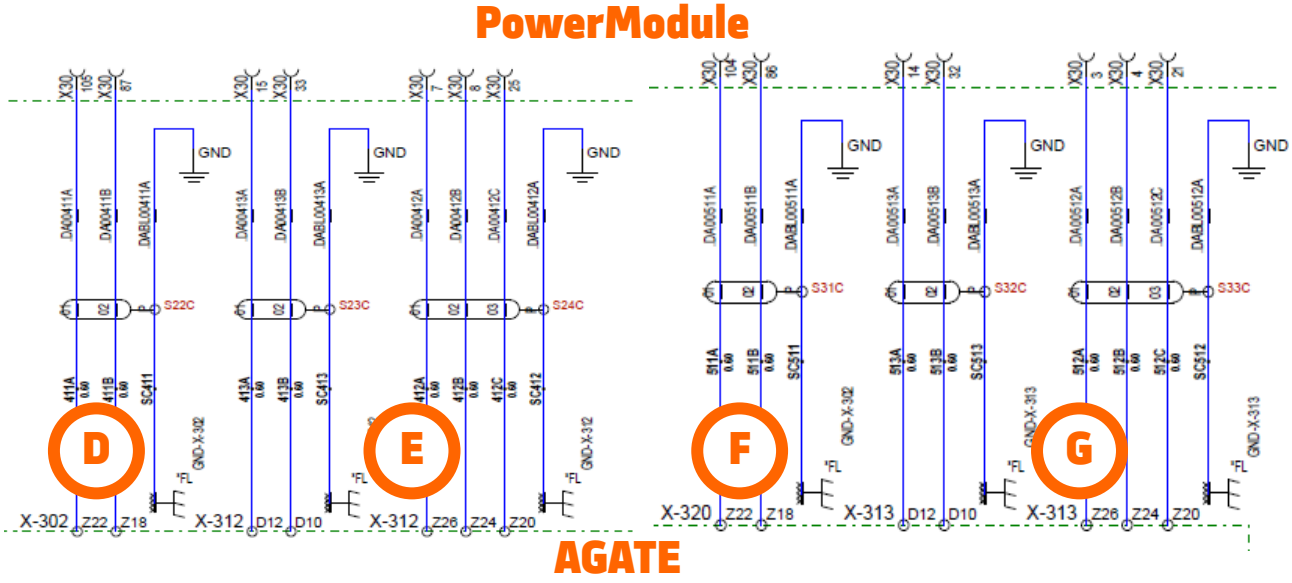
A. Auxiliary contact from line contactor KL1 is acquired by the Agate
B. Auxiliary contact from precharge contactor KPRE1 is acquired by the Agate
C. PMM configuration only : auxiliary contact from motor contactor KMOT1 is acquired by the Agate
D. PMM configuration only : auxiliary contact from motor contactor KMOT2 is acquired by the Agate
E. Inside the FSCB board are installed specific load resistors in order to guarantee minimum current in the aux contacts



F. Line contactor KL1 main coil is energized by K5 contact
G. Precharge contactor KPRE1 main coil is energized by K6 contact, only if line contactor is open



A. TAL_P1 current (positive) standard current sensor (Hall-effect) is directly acquired by the Agate
B. TAL_N1 DC current (negative) standard current sensor (Hall-effect) is directly acquired by the Agate
C. TVL1 DC voltage transducer is directly acquired by the Agate



D. Chopper1 gate drive power supply
E. Chopper1 IGBT pulse command and status feedback
F. Chopper1 gate drive power supply
G. Chopper1 IGBT pulse command and status feedback

4.8.2.5. Winscope / Traintracer TDB

Use **AutotestLPT.tdb** to support investigation.
Follow on-screen notes in order to:

- Close and open precharge contactor and verify correct feedback
- Close and open line contactor and verify correct feedback
- Close and open motor contactors and verify correct feedback

4.8.3. Verifications - Failure 602

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Line voltage sensor AV100-1000/SP2	**TVL1**
	Precharge contactor LTC100	**KPRE1**
	LV contactor LC1D126BLS170	**K6**
	Power module ONIX850DLP3	**ONIX850DLP3**

4.8.3.1. Message xx-29-37. Precharge contactor doesn't close

AC3mini commands precharge contactor **KPRE1** using an auxiliary relay **K6**, and checks correct functionality reading an auxiliary contact of **KPRE1** itself.

1 ***REPLACE*** **K6**
VERIFY precharge contactor activation and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation

3 ***REPLACE*** **KPRE1**
VERIFY precharge contactor activation and feedback

4 ***CHECK*** the cabling
VERIFY that electrical connections are good

4.8.3.2. Message xx-29-38. Short circuit during precharge

AC3mini detects that, even if precharge contactor **KPRE1** closes correctly, the DC voltage doesn't rise as supposed to be.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation running again the low power test sequence

2 ***REPLACE*** **TVL1**
VERIFY that the low power test sequence is completed successfully

3 ***CHECK*** the cabling
VERIFY that electrical connections are good

4 ***REPLACE*** **ONIX850DLP3**
VERIFY that the low power test sequence is completed successfully

4.8.4. Verifications - Failure 603

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Line contactor Sécheron	**KL1**
	LV contactor LC1D126BLS170	**K5**

4.8.4.1. Message xx-29-39. Line contactor doesn't close

AC3mini commands line contactor **KL1** using an auxiliary relay **K5**, and checks correct functionality reading an auxiliary contact of **KL1** itself.

1 ***REPLACE*** **K5**
VERIFY precharge contactor activation and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation

3 ***REPLACE*** **KL1**
VERIFY precharge contactor activation and feedback

4 ***CHECK*** the cabling
VERIFY that electrical connections are good

4.8.5. Verifications - Failure 605

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Line current sensor 1000A 250mA	**TAL_P1, TAL_N1**
	Power module ONIX850DLP3	**ONIX850DLP3**
Braking Rheostat	Braking rheostat (1/2 rheostat)	**RH1**

4.8.5.1. Message xx-29-3B. Braking chopper1 KO or DC PosCurr Fault
4.8.5.2. Message xx-29-3C. Braking chopper1 KO or DC NegCurr Fault

AC3mini activates with a fixed duty cycle the braking chopper 1 (part of the **ONIX850DLP3** power module) and checks that DC current value (measured by DC transducers **TAL_P1** and **TAL_N1**) is consistent with the rheostat **RH1** ohmic value.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the low power test sequence is completed successfully

2 ***CHECK*** cabling between Agate rack connectors and the measuring device **TAL_P1** or **TAL_N1** (depending on the diagnostic message) removing AC3mini
VERIFY that electrical connections are good

4 ***REPLACE*** **TAL_P1** or **TAL_N1** depending on the diagnostic message
VERIFY that the low power test sequence is completed successfully

5 ***CHECK*** the cabling to **RH1**
VERIFY that electrical connections are good

4.8.6. Verifications - Failure 608

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Power module ONIX850DLP3	**ONIX850DLP3**
Braking Rheostat	Braking rheostat (1/2 rheostat)	**RH2**

4.8.6.1. Message xx-29-3D. Braking chopper2 KO or DC PosCurr Fault
4.8.6.2. Message xx-29-3E. Braking chopper2 KO or DC NegCurr Fault

AC3mini activates with a fixed duty cycle the braking chopper 1 (part of the **ONIX850DLP3** power module) and checks that DC current value (measured by DC transducers **TAL_P1** and **TAL_N1**) is consistent with the rheostat **RH2** ohmic value.

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the low power test sequence is completed successfully

2 ***CHECK*** the cabling to **RH2**
VERIFY that electrical connections are good

4.8.7. Verifications - Failure 611

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Three pole motor contactor LTHS0320HFO0	**KMOT1, KMOT2**
	LV contactor LC1D126BLS170	**K10, K11**

4.8.7.1. Message xx-29-20. Motor Contactor1 unable to close

AC3mini commands motor contactor **KMOT1** using an auxiliary relay **K10**, and checks correct functionality reading the auxiliary contact of **KMOT1** itself.

1 ***REPLACE*** **K10**
VERIFY motor contactor activation and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation

3 ***CHECK*** the cabling
VERIFY that electrical connections are good

4 ***REPLACE*** **KMOT1**
VERIFY contactor activation and feedback

4.8.7.2. Message xx-29-22. Motor Contactor2 unable to close

AC3mini commands motor contactor **KMOT2** using an auxiliary relay **K11**, and checks correct functionality reading the auxiliary contact of **KMOT2** itself.

1 ***REPLACE*** **K11**
VERIFY motor contactor activation and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation

3 ***CHECK*** the cabling
VERIFY that electrical connections are good

4 ***REPLACE*** **KMOT2**
VERIFY contactor activation and feedback

4.8.8. Verifications - Failure 613

Involved LRUs		
TBCU	AGATE	**AC3mini**
	Three pole motor contactor LTHS0320HFO0	**KMOT1, KMOT2**
	LV contactor LC1D126BLS170	**K10, K11**

4.8.8.1. Message xx-29-21. Motor Contactor1 fault during open

AC3mini commands motor contactor **KMOT1** using an auxiliary relay **K10**, and checks correct functionality reading the auxiliary contact of **KMOT1** itself.

1 ***REPLACE*** **K10**
VERIFY motor contactor activation and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation and feedback

3 ***CHECK*** the cabling
VERIFY that electrical connections are good

4 ***REPLACE*** **KMOT1**
VERIFY contactor activation and feedback

4.8.8.2. Message xx-29-23. Motor Contactor2 fault during open

AC3mini commands motor contactor **KMOT2** using an auxiliary relay **K11**, and checks correct functionality reading the auxiliary contact of **KMOT2** itself.

1 ***REPLACE*** **K11**
VERIFY motor contactor activation and feedback

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY contactor activation and feedback

3 ***CHECK*** the cabling
VERIFY that electrical connections are good

4 ***REPLACE*** **KMOT2**
VERIFY contactor activation and feedback

5. Traction failures

5.1. Introduction

During normal operation, Traction Control SW always performs a complete monitoring of the Traction System behavior, taking all the protective actions is case of faults detected on the internal components.

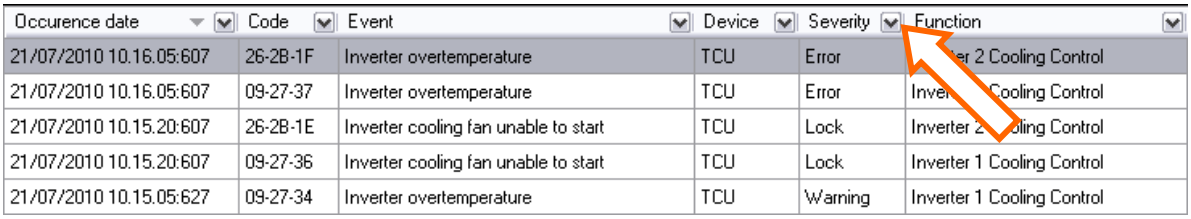
Both the (supposed) root-cause as the protective action is traced in the event memory to support the maintenance team during troubleshooting analysis.
In any case, Traction System is able to protect itself disabling part or the whole functionalities without specific operation of the driver or the master controller (TCMS).

5.2. Anomalous vehicle behavior

Notes and remarks reported by the driver during vehicle service could help to understand which kind of fault occurred. The following table could guide to filter the events related to the main traction fault.

Vehicle behavior	Filter for …
The Traction System is out-of-order. A lock icon is showed on the DDU.	**Lock**
During normal operation, the driver reports that motor torque was missing for few seconds, than reappeared	**Error**
Traction system was working correctly, but after a change of cabin, it didn't restart	**Warning**
Mechanical brake of the motorized bogie is not working	*Check for fault messages listed in 5.17*
Motor torque is missing sometimes for a while; electrical values related to the Traction System reported on the DDU are set to zero or frozed	*Troubles on MVB communication. Check for fault messages in 5.24*
Anomalous behavior of the manipulator (no traction effort or no electrical effort in service brake)	*Troubles on manipulator wiring. Check for fault messages in 5.23*

Remember the possibility to filter events using the related button.



Occurence date	Code	Event	Device	Severity	Function
21/07/2010 10.16.05:607	26-2B-1F	Inverter overtemperature	TCU	Error	…er 2 Cooling Control
21/07/2010 10.16.05:607	09-27-37	Inverter overtemperature	TCU	Error	Inver… Cooling Control
21/07/2010 10.15.20:607	26-2B-1E	Inverter cooling fan unable to start	TCU	Lock	Inverter 2 …ling Control
21/07/2010 10.15.20:607	09-27-36	Inverter cooling fan unable to start	TCU	Lock	Inverter 1 Cooling Control
21/07/2010 10.15.05:627	09-27-34	Inverter overtemperature	TCU	Warning	Inverter 1 Cooling Control

5.3. Event list

Here the complete event list generated by the Traction SW when the system is in Operational Mode.

TrainTracer		Ref	Stack	Text message
xx-27-11		-	Lock	Parameter error or out of range
xx-27-12		-	Message	Motor 1 Off
xx-27-13		-	Message	Motor 2 Off
xx-27-14		-	Message	Traction Isolated by TCMS
xx-27-15		5.4	Lock	Repetitive overcurrent on motor 1
xx-27-16		5.4	Lock	Repetitive overcurrent on motor 2
xx-27-17		5.5	Lock	Repetitive overcurrent on DC link
xx-27-18		5.6	Lock	Repetitive overvoltage on DC link
xx-27-19		5.22	Warning	DIR1 & DIR2 digital inputs both to TRUE
xx-27-1A		5.22	Lock	Main DIR error
xx-27-1B		5.5	Lock	Differential Current fault
xx-27-1C		-	Message	HSCB opening request from TCMS
xx-27-1D		5.8	Error	Line or Precharge Contactor stucked
xx-27-1E		5.20	Error	Precharge sequence fault
xx-27-1F		5.20	Lock	Repetitive precharge sequence fault
xx-27-20	M1	5.7	Error	Motor contactor stuck
xx-2B-08	M2			
xx-27-21	M1	5.7	Error	Motor contactor unabletoclose
xx-2B-09	M2			
xx-27-22	M1	5.7	Lock	Repetitive motor contactor unabletoclose
xx-2B-0A	M2			
xx-27-23	R1	5.9	Warning	Rheo overtemperature
xx-2B-0B	R2			
xx-27-24	R1	5.9	Error	Rheo overtemperature
xx-2B-0C	R2			
xx-27-25	R1	5.9	Lock	Repetitive rheo overtemperature
xx-2B-0D	R2			
xx-27-26	M1	5.10	Warning	Motor overtemperature
xx-2B-0E	M2			
xx-27-27	M1	5.10	Error	Motor overtemperature
xx-2B-0F	M2			
xx-27-28	M1	5.10	Lock	Repetitive motor overtemperature
xx-2B-10	M2			
xx-27-29	M1	-	Warning	Rollback detected
xx-2B-11	M2			
xx-27-2A		5.12	Warning	GRF cooling water low level
xx-27-2B		5.13	Warning	GRF cooling water high temperature 85
xx-27-2C		5.11	Warning	GRF cooling pump or fan contactors stuck
xx-27-2D		5.11	Lock	GRF cooling pump contactor unabletoclose
xx-27-2E		5.12	Lock	GRF cooling water low pressure
xx-27-2F		5.13	Error	GRF cooling water very high temperature
xx-27-30		5.13	Lock	GRF repetitive water very high temp
xx-27-31			Lock	SW not compatible with AC3conf 1AC3/2AC3
xx-27-32	M1	5.14	Warning	Motor overspeed
xx-2B-1A	M2			
xx-27-33	M1	5.14	Lock	Repetitive motor overspeed
xx-2B-1B	M2			
xx-27-34	I1	5.16	Warning	Inverter overtemperature
xx-2B-1C	I2			
xx-27-35	I1	5.15	Warning	Inverter cooling fan stuck
xx-2B-1D	I2			
xx-27-36	I1	5.15	Lock	Inverter cooling fan unable to start
xx-2B-1E	I2			
xx-27-37	I1	5.16	Error	Inverter overtemperature
xx-2B-1F	I2			
xx-27-38	I1	5.16	Lock	Repetitive inverter overtemperature
xx-2B-20	I2			

xx-27-39		-	Message	APS controller request to cut traction
xx-27-3B		-	Message	HSCB opened due to Safety Brake request
xx-27-3C		5.11	Warning	GRF cooling fan unable to start
xx-27-3D		5.11	Warning	GRF cooling fan unable to pass in hi spd
xx-27-3E		5.13	Message	GRF water temperature incoherence
xx-27-3F		-	Message	Traction capabilities available Inv1
xx-27-40		-	Message	Traction capabilities not avail Inv1
xx-27-41		-	Message	Traction capabilities available Inv2
xx-27-42		-	Message	Traction capabilities not avail Inv2
xx-27-43		-	Message	Elec brake capabilities available Inv1
xx-27-44		-	Message	Elec brake capabilities not avail Inv1
xx-27-45		-	Message	Elec brake capabilities available Inv2
xx-27-46		-	Message	Elec brake capabilities not avail Inv2
xx-27-47		-	Message	Line contactor unable to close
xx-27-48		-	Message	Precharge contactor unable to close
xx-27-49		-	Message	RESCUE Mode Enabled
xx-27-4A		-	Message	RESCUE Mode Disabled
xx-27-4B		-	Message	Traction Unit is Locked
xx-27-4C		-	Message	Traction Unit is Unlocked
xx-27-4D		-	Message	TCMS send a reset to unlock TractionUnit
xx-27-4E		-	Message	Traction Unit opens HSCB
xx-27-4F		-	Message	Traction Unit permits to close HSCB
xx-27-50		5.17	Message	Fault on BCU relay auxiliary contact
xx-27-51		-	Message	Line contactor stuck
xx-27-52		5.17	Message	Fault on BCU brake applied feedback
xx-27-53		-	Message	Precharge contactor stuck
xx-27-54		-	Message	Precharge authoriz ON command from TCMS
xx-27-55		-	Message	Precharge authoriz OFF command from TCMS
xx-27-57		5.17	Message	Fault on BCU brake released feedback
xx-27-58		5.17	Message	Repetitive fault on BCU
xx-27-59		-	Message	Current limitation ON during braking
xx-27-5A		-	Message	Current limitation OFF during braking
xx-27-5B		-	Message	Emergency Brake request ON
xx-27-5D		-	Message	Speed information RefSpeed not valid
xx-27-5E		-	Message	Speed information motor1 not valid
xx-27-5F		-	Message	Speed information motor2 not valid
xx-27-60		-	Message	Speed information add axle not valid
xx-27-61		-	Message	LineCont Open after TCMS Traction Isol
xx-27-66		-	Message	GRF warning state detected
xx-27-67		-	Message	GRF no more in warning state
xx-27-68		-	Message	GRF fault condition detected
xx-27-69		-	Message	GRF no more in fault
xx-27-6A		-	Message	Current limit during traction active
xx-27-6B		-	Message	Current limit during traction not active
xx-27-6C		-	Message	Speed limitation active
xx-27-6D		-	Message	Speed limitation not active
xx-27-6E		-	Message	Torque limitation M1 active
xx-27-6F		-	Message	Torque limitation M1 not active
xx-27-70		-	Message	BCU isolated by the driver
xx-27-71		-	Message	BCU not isolated by the driver
xx-27-72		-	Message	BCU relay energized
xx-27-73		-	Message	BCU relay de-energized
xx-27-74		5.18	Lock	DC current positive sensor offset error
xx-27-75		5.18	Lock	DC current negative sensor offset error
xx-27-76		-	Message	Torque limitation M2 active
xx-27-77		-	Message	Torque limitation M2 not active
xx-27-78		-	Message	Power limitation active
xx-27-79		-	Message	Power limitation not active
xx-27-7A		-	Lock	DSP management input incorrect conf code
xx-27-7B	M1	5.19	Error	Unexpected low motor curr when running
xx-2B-63	M2			

xx-27-7C	M1	5.19	Lock	Repetitive low motor curr when running
xx-2B-64	M2			
xx-27-7D	M1	5.19	Lock	Motor current sensor fault
xx-2B-65	M2			
xx-27-7E	M1	5.19	Error	Motor current unbalance
xx-2B-66	M2			
xx-27-7F	M1	5.19	Lock	Motor current unbalance repetitive fault
xx-2B-67	M2			
xx-27-80		5.21	Lock	DC Bus discharge time too long
xx-27-81		5.23	Message	Elec effort incoherence MVB - trainwires
xx-27-82		-	Message	LineCont and Motor Contactors are open
xx-27-83		-	Lock	Current DSP state out of range
xx-27-84		5.24	Message	MVB Communication lost
xx-27-85		5.24	Message	MVB Communication OK
xx-27-86		-	Message	Motor1 Off by TCMS
xx-27-87		-	Message	Motor1 On by TCMS
xx-27-88		-	Message	Motor2 Off by TCMS
xx-27-89		-	Message	Motor2 On by TCMS
xx-27-8A		5.4	Error	Phase U overcurrent motor 1
xx-27-8B		5.4	Error	Phase V overcurrent motor 1
xx-27-8C		5.4	Error	Phase W overcurrent motor 1
xx-27-8D		5.4	Error	Phase U overcurrent motor 2
xx-27-8E		5.4	Error	Phase V overcurrent motor 2
xx-27-8F		5.4	Error	Phase W overcurrent motor 2
xx-27-90		5.5	Error	Overcurrent on DC link
xx-27-91		5.6	Error	Overvoltage on DC link
xx-27-92		5.23	Message	Cut traction due to mech brake eff req
xx-27-93		5.20	Message	Precharge time too long
xx-27-94		5.20	Message	Precharge resistor overtemperature
xx-27-95		5.24	Lock	Incorrect TCU Id LOC configuration
xx-27-9A			Message	Slip slide fault
xx-27-9B			Message	Slide detected
xx-27-9C			Message	Slip detected
xx-27-9D			Error	Inconsistency between Torque Dem & Real
xx-27-9E		5.22	Lock	Fault on EBT2 DI board (validity flag)
xx-27-9F		5.22	Lock	Fault on EBT4 DI board (validity flag)
xx-27-A0		5.22	Lock	Fault on SBT6 DO board (validity flag)
xx-27-A1		5.22	Lock	Fault on SST3 DO board (validity flag)
xx-27-A2		5.22	Lock	Fault on SST7 DO board (validity flag)
xx-27-A3			Message	Local AC3 detect a fault in Remote Unit
xx-27-A4			Lock	Local Rollback Fault detect by Rem Unit
xx-27-A5			Lock	Local EMB Fault detect by Remote Unit
xx-27-A6			Lock	Local SSB Fault detect by Remote Unit
xx-27-A7			Lock	Local SlipSlide Fault detect by Rem Unit
xx-27-A8	M1		Message	Motor contactor is open
xx-2B-90	M2			

5.4. HW Phase Overcurrent

5.4.1. Description

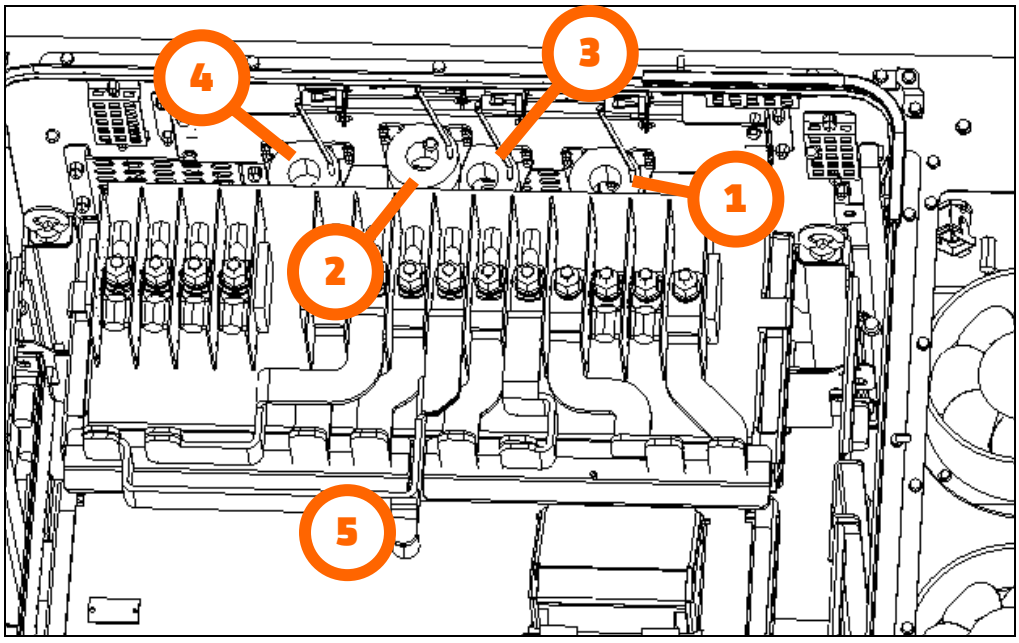
Traction converter is protected against phase overcurrent, generally due to HW faults inside the power module or motor. When phase current overpass a certain threshold, inverter pulses are inhibited and the line contactor opens. After few seconds, the traction system automatically try to restart itself.
In case of repetitive faults in a short time, Traction system is declared unavailable and specific HW checks must be done.

Here below the involved messages.

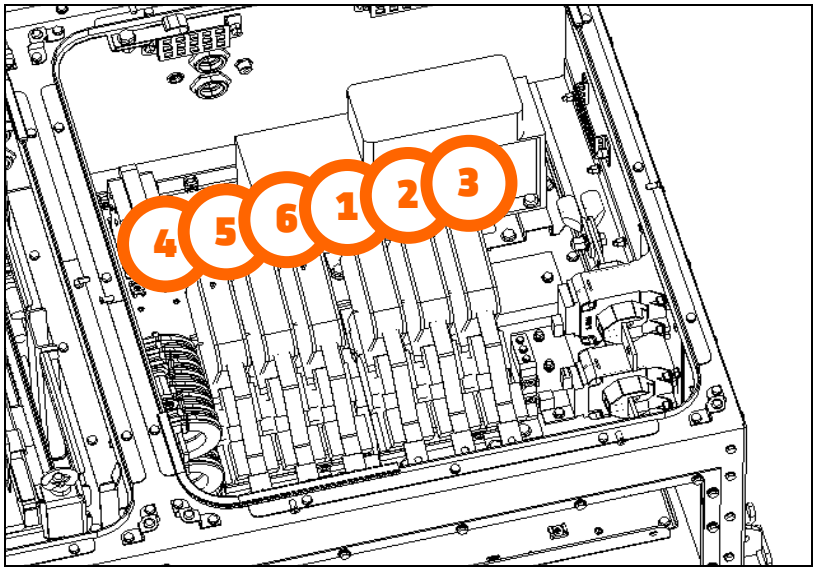
TrainTracerCode		Stack	Text message
xx-27-8A		Error	Phase U overcurrent motor 1
xx-27-8B		Error	Phase V overcurrent motor 1
xx-27-8C		Error	Phase W overcurrent motor 1
xx-27-8D		Error	Phase U overcurrent motor 2
xx-27-8E		Error	Phase V overcurrent motor 2
xx-27-8F		Error	Phase W overcurrent motor 2
xx-27-15		Lock	Repetitive overcurrent on motor 1
xx-27-16		Lock	Repetitive overcurrent on motor 2

5.4.2. Involved LRUs

5.4.2.1. TBCU

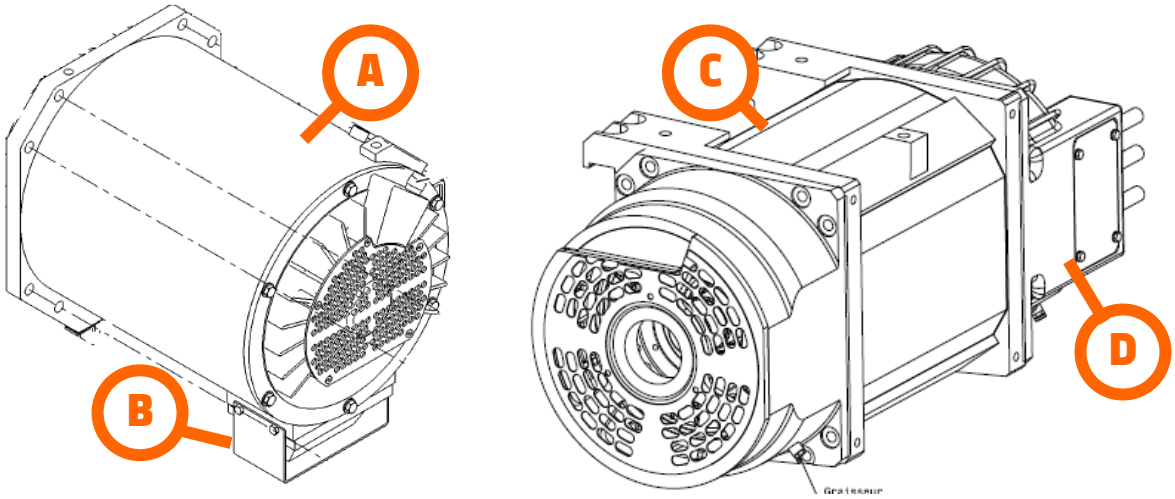


POS	Description	
1	Motor phase current sensor LF505-S/SP28	**TAM_U1**
2	Motor phase current sensor LF505-S/SP28	**TAM_V1**
3	Motor phase current sensor LF505-S/SP28	**TAM_U2**
4	Motor phase current sensor LF505-S/SP28	**TAM_V2**
5	Power module ONIX850DLP3	**ONIX850DLP3**



POS	Description	
1	Motor1 phase connections	**U1**
2	Motor1 phase connections	**V1**
3	Motor1 phase connections	**W1**
4	Motor2 phase connections	**U2**
5	Motor2 phase connections	**V2**
6	Motor2 phase connections	**W2**

5.4.2.2. Motors



POS	Description	
A	MAS motor 4HGA1433	**M1, M2**
B	MAS motor electrical connections	
C	PMM motor 6LMS1052	**M1, M2**
D	PMM motor electrical connections	

5.4.2.3. TBCU HV Scheme

Please refer to chapter 4.8 for details related to motor current sensors interface with the Agate.

5.4.2.4. TBCU LV Scheme

Please refer to chapter 4.6 for details related to motor current sensors interface with the Agate.

5.4.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to eventually discover faults on motor current sensors or power module gate drives

2 ***CHECK*** phase to phase impedance value of the motor (**M1** if the diagnostic message is related to this one, **M2** otherwise), disconnecting it from the motor contactors (or output connection in case of MAS motors)
VERIFY that impedance value are equals amongs phases

3 ***CHECK*** phase to ground impedance value of the motor (**M1** if the diagnostic message is related to this one, **M2** otherwise), disconnecting it from the motor contactors (or output connection in case of MAS motors)
VERIFY that impedance value are equals amongs phases

4 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

5.5. DC Overcurrent - Differential Current Fault

5.5.1. Description

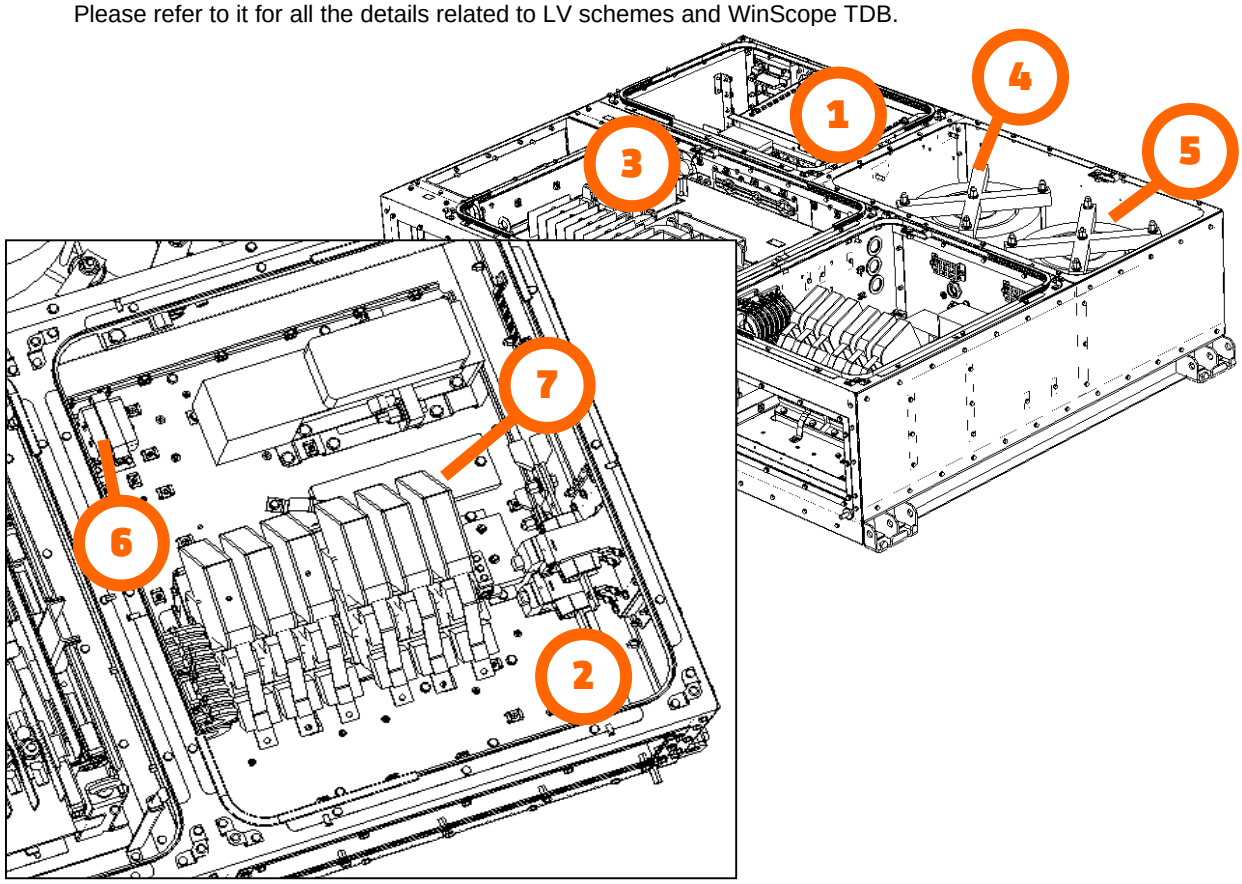
Traction converter is protected against overcurrent at DC side, usually due to HW faults inside the power module or severe transients on the catenary voltage.
When DC current overpass a certain threshold, inverter pulses are inhibited and the line contactor opens. After few seconds, the traction system automatically try to restart itself. In case of repetitive faults in a short time, Traction system is declared unavailable and specific HW checks must be done.
Differential Current fault appears when the two measured DC currents (by the related current sensors) are not consistent. Due to the severity of this fault (i.e. loss of dielectric isolation to ground) the Traction System is immediately Locked.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-90		Error	Overcurrent on DC link
xx-27-17		Lock	Repetitive overcurrent on DC link
xx-27-1B		Lock	Differential Current fault

5.5.2. Involved LRUs

DC current sensors are tested by the Low Power Test specific sequence presented in 4.8.
Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	AGATE	**AC3mini**
2	Line current sensor 1000A 250mA	**TAL_P1, TAL_N1**
3	Power module ONIX850DLP3	**ONIX850DLP3**
4	Inductor 2mH 200A	**LF1**
5	Inductor 2mH 200A	**LF2**
6	Precharge contactor LTC100	**KPRE1**
7	Precharge resistor 30 OHMS 280W	**RPRE1**

5.5.3. Verifications

In case of **Repetitive overcurrent on DC link** do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to eventually discover faults on current sensors, power module, shortcircuit on DC bus

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

In case of **Differential Current fault** do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to eventually discover faults on current sensors, power module, or the Agate itself

2 ***CHECK*** dielectric isolation to ground
VERIFY that dielectric resistance is not compromize, otherwise check the HV circuit to detect which LRU is responsible of the fault **(ONIX850DLP3, LF1, LF2, KPRE1, RPRE1)**

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

5.6. HW DC Overvoltage

5.6.1. Description

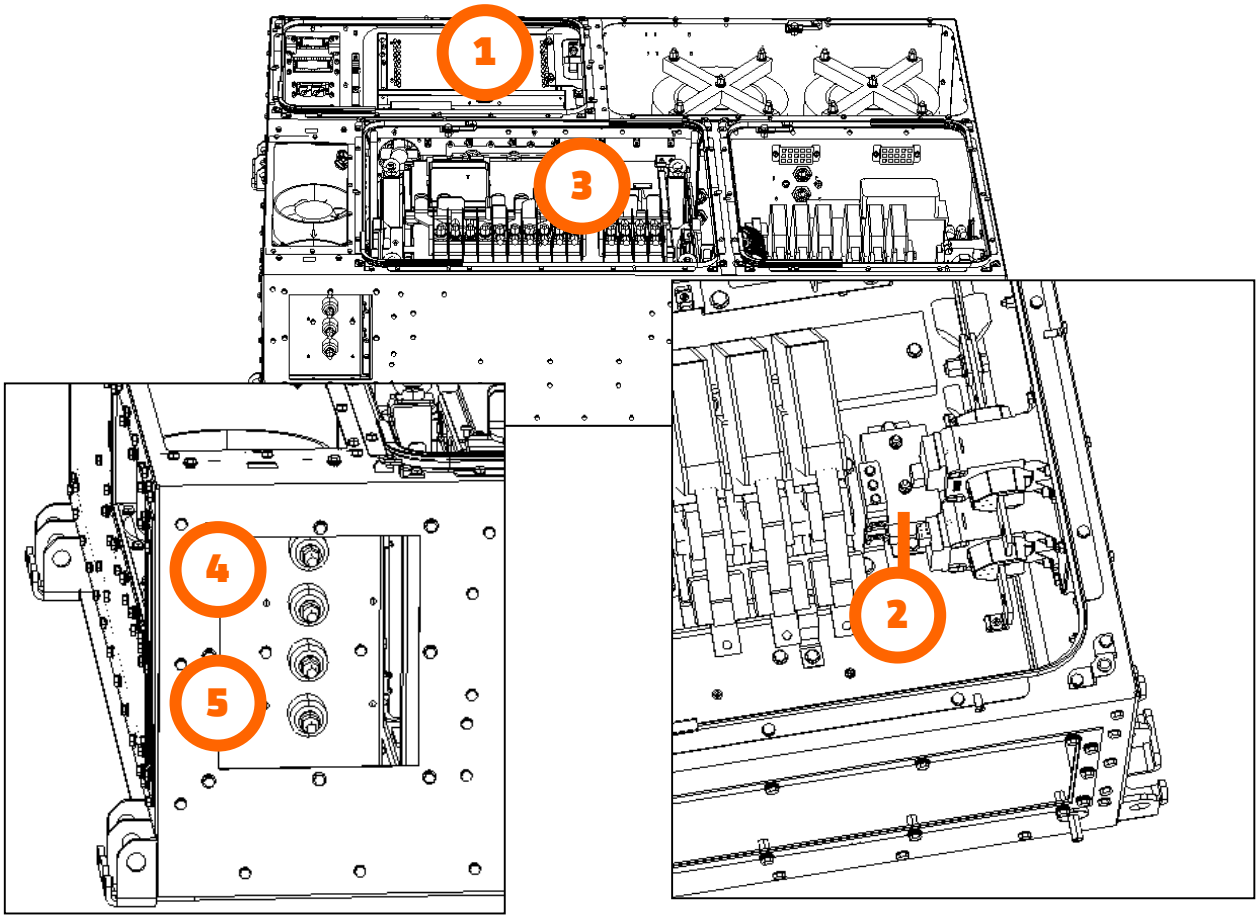
Traction converter is protected against overvoltage at DC side, usually due to severe transients on the catenary voltage or HW faults inside the power module, braking rheostats or Agate.
When DC voltage overpass a certain threshold, inverter pulses are inhibited and braking chopper is used to clamp this energy. After a while, the traction system automatically try to restart itself.
In case of repetitive faults in a short time, Traction system is declared unavailable and specific HW checks must be done.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-91		Error	Overvoltage on DC link
xx-27-18		Lock	Repetitive overvoltage on DC link

5.6.2. Involved LRUs

DC HV circuit is tested by the Low Power Test specific sequence presented in 4.8.
Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	AGATE	**AC3mini**
2	Line voltage sensor AV100-1000/SP2	**TVL1**
3	Power module ONIX850DLP3	**ONIX850DLP3**
4	Braking rheostat (1/2 rheostat)	**RH1**
5	Braking rheostat (1/2 rheostat)	**RH2**

5.6.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to eventually discover faults on current sensors, power module, braking chopper or rheostat

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

5.7. Motor contactors faults

5.7.1. Description

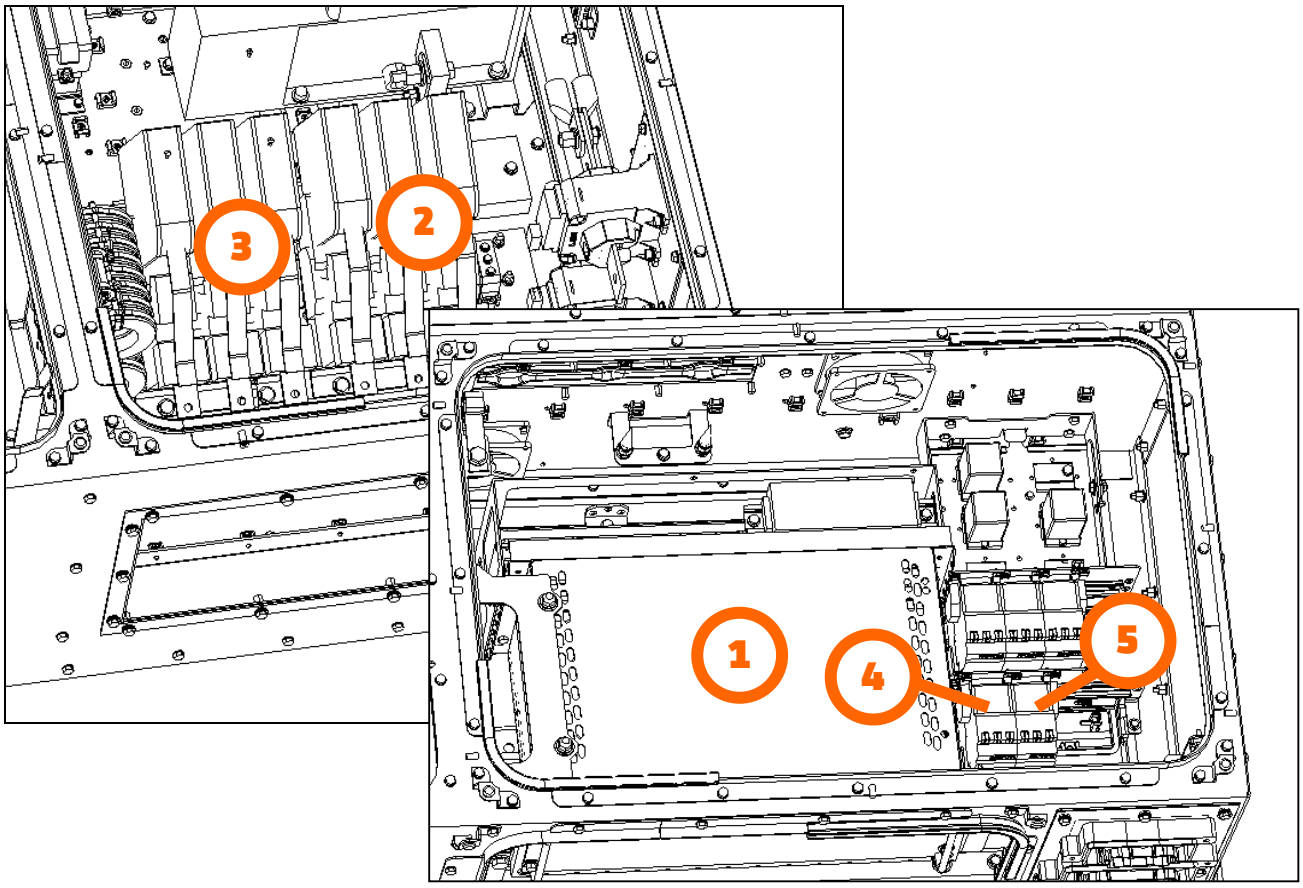
PMM Traction Converter is equipped with motor contactors. Correct behavior of these devices (one for each motor) is done acquiring the status of the related auxiliary contact. In case of inconsistency between command (that energizes an auxiliary relay which supplies the main coil) and feedback, an error is traced. In case of repetitive faults in a short time, the related motor is declared out-of-order.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-20	M1	Error	Motor contactor stuck
xx-2B-08	M2		
xx-27-21	M1	Error	Motor contactor unabletoclose
xx-2B-09	M2		
xx-27-22	M1	Lock	Repetitive motor contactor unabletoclose
xx-2B-0A	M2		

5.7.2. Involved LRUs

Motor contactors are fully tested by the Low Power Test specific sequence presented in 4.8. Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	AGATE	**AC3mini**
2	Three pole motor contactor LTHS0320HFO	**KMOT1**
3	Three pole motor contactor LTHS0320HFO	**KMOT2**
4	LV contactor LC1D126BLS170	**K10**
5	LV contactor LC1D126BLS170	**K11**

5.7.3. Verifications

Even if the text messages are generic, the TrainTraceCode permits to identify which contactor is not working, as on the table presented before.
M1 is related to **K10** and **KMOT1**.
M2 is related to **K11** and **KMOT2**.

1 ***RUN LOW POWER TEST (EPR)*** to identify possible root cause fault

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

5.8. Line / Precharge contactors faults

5.8.1. Description

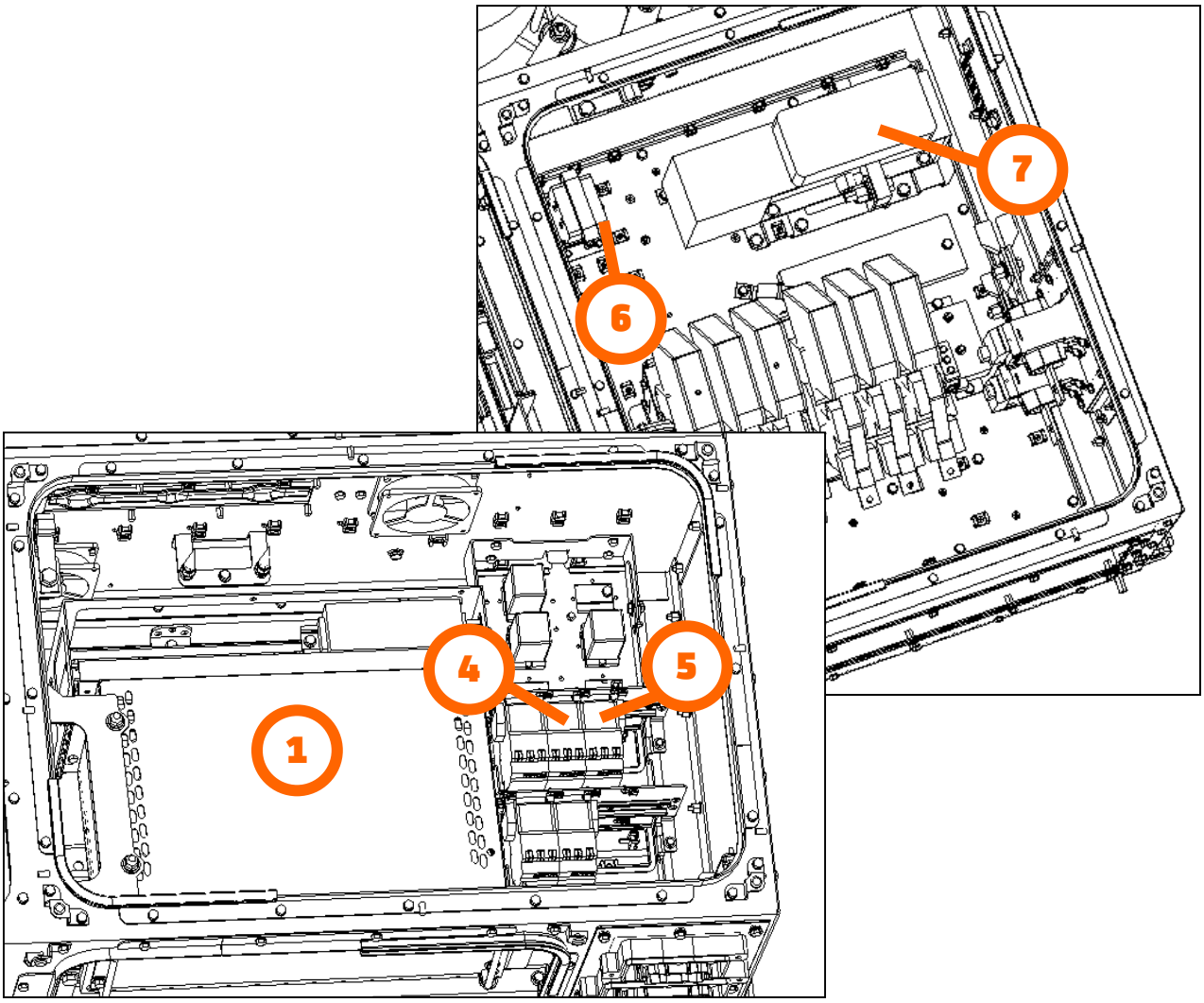
Precharge contactor and line contactor are monitored using the status of the related auxiliary contact. In case of inconsistency between command (that energizes an auxiliary relay which supplies the main coil) and feedback an error is traced.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-1D		Error	Line or Precharge Contactor stucked

5.8.2. Involved LRUs

Line and precharge contactors are fully tested by the Low Power Test specific sequence presented in 4.8. Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	AGATE	**AC3mini**
2	Line contactor Sécheron	**KL1**
3	Precharge contactor LTC100	**KPRE1**
4	LV contactor LC1D126BLS170	**K5**
5	LV contactor LC1D126BLS170	**K6**

5.8.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to identify possible root cause fault

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

5.9. Rheo Overtemperature

5.9.1. Description

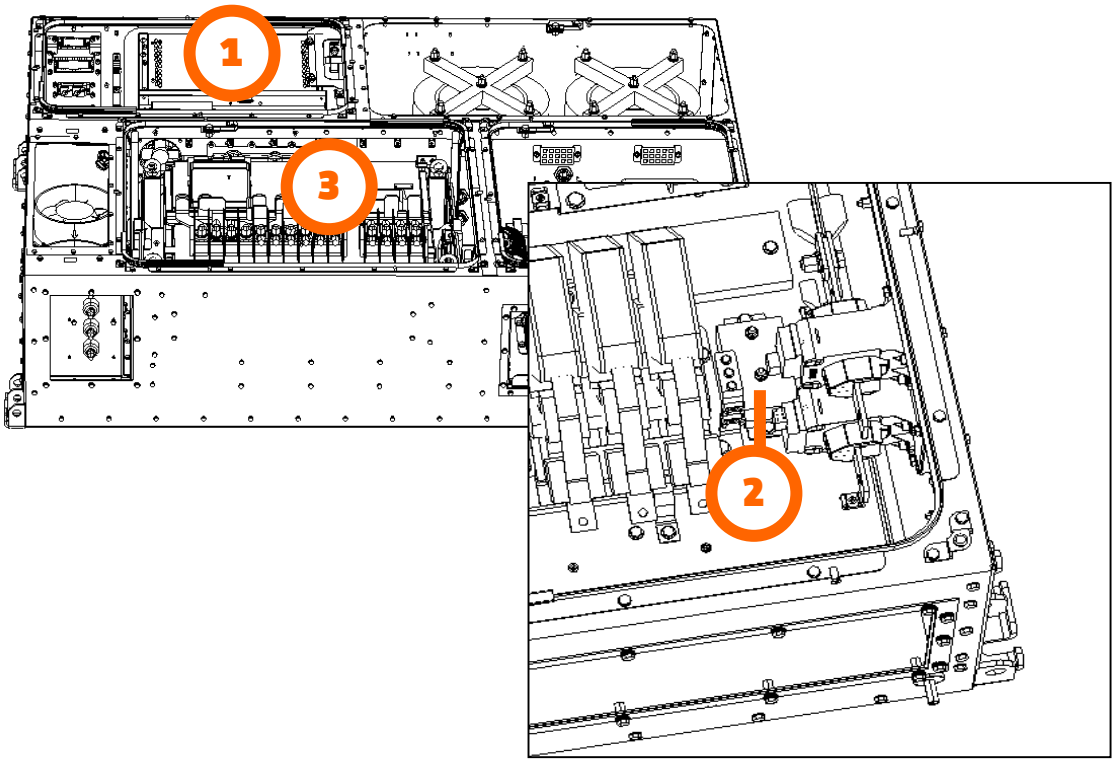
Rheostats (one for each inverter section, installed in the same box) are monitored using a thermal model that estimates the working temperature (hot-spot) in realtime; estimation is done by knowledge of DC voltage and the chopper dutycycle.
When the estimated temperature overpass a defined warning threshold, a message is traced in the event memory, and the motor power is reduced by a fixed percentage to prevent additional troubles.
If the temperature overpass a successive higher threshold, inverter pulses are inhibited until the temperature fall down to an acceptable value.
In case of repetitive faults in a short time, the complete Traction Unit is declared unavailable.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-23	R1	Warning	Rheo overtemperature
xx-2B-0B	R2		
xx-27-24	R1	Error	Rheo overtemperature
xx-2B-0C	R2		
xx-27-25	R1	Lock	Repetitive rheo overtemperature
xx-2B-0D	R2		

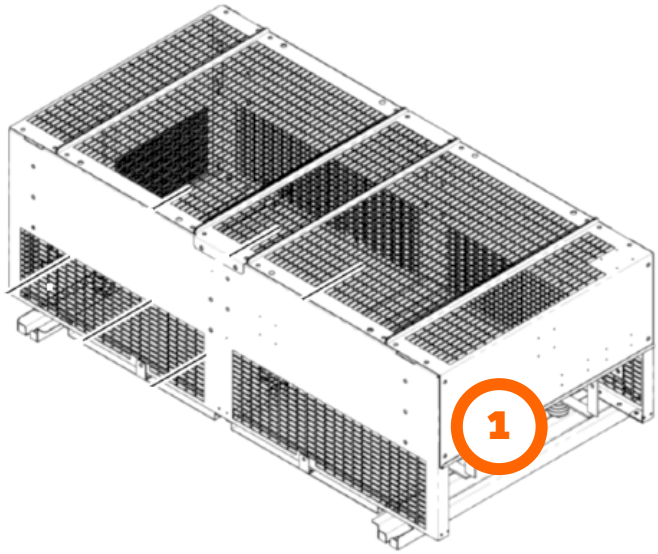
5.9.2. Involved LRUs

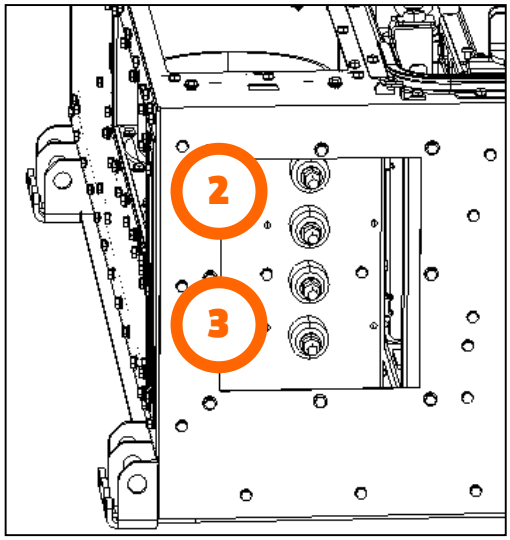
5.9.2.1. TBCU



POS	Description	
1	AGATE	**AC3mini**
2	Line voltage sensor AV100-1000/SP2	**TVL1**
3	Power module ONIX850DLP3	**ONIX850DLP3**

5.9.2.2. Rheostat





POS	Description	
1	AGATE	**AC3mini**
2	Braking rheostat connection	**RH1**
3	Braking rheostat connection	**RH2**

5.9.3. Verifications

Even if the text messages are generic, the TrainTraceCode permits to identify which rheostat is supposed to have troubles, as on the table presented before.
R1 is related to **RH1**.
R2 is related to **RH2**.

1 ***RUN LOW POWER TEST (EPR)*** to identify possible faults related to the rheostat devices or voltage sensor

2 ***CHECK*** the cabling between the traction converter and the rheostats
VERIFY that electrical connections are good

3 ***CHECK*** the ohmic value of the rheostat, disconnecting power cables from the TBCU
VERIFY that resistance value is around 1.15ohm (nominal value)

5.10. Motor Overtemperature

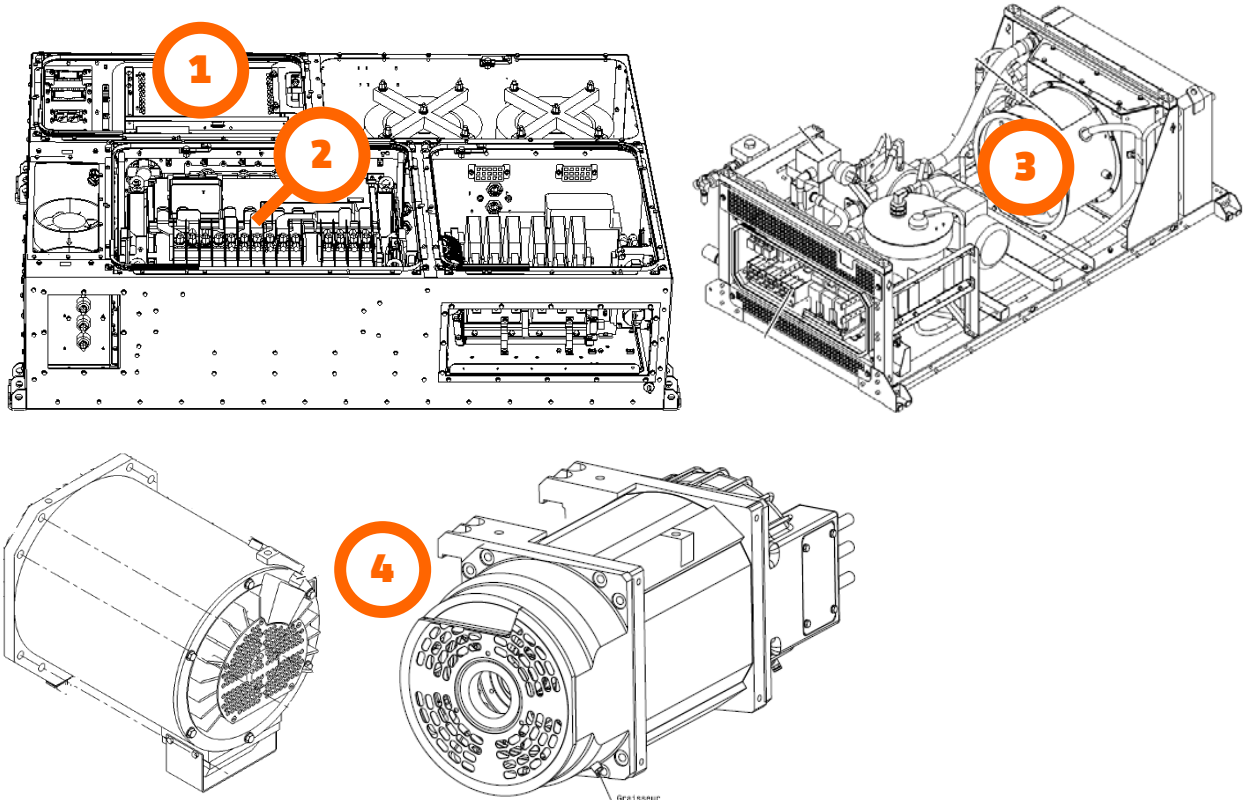
5.10.1. Description

Each motor are monitored using a thermal model that estimates the working temperature (hot-spot) in realtime.
When the estimated temperature overpass a defined warning threshold, a message is traced in the event memory, and the motor torque is reduced by a fixed percentage to prevent additional troubles.
If the temperature overpass a successive higher threshold, inverter pulses are inhibited until the temperature fall down to an acceptable value.
In case of repetitive faults in a short time, the motor is disabled until a system reboot.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-26	M1	Warning	Motor overtemperature
xx-2B-0E	M2		
xx-27-27	M1	Error	Motor overtemperature
xx-2B-0F	M2		
xx-27-28	M1	Lock	Repetitive motor overtemperature
xx-2B-10	M2		

5.10.2. Involved LRUs



POS	Description	
1	AGATE	**AC3mini**
2	Motor phase current sensor LF505-S/SP28	**TAM_U1, TAM_V1, TAM_U2, TAM_V2**
3	GRF	**-**
4	Motors	**M1, M2**

5.10.3. Verifications

Even if the text messages are generic, the TrainTraceCode permits to identify which motor is supposed to have troubles, as on the table presented before.
M1 is related to **motor1.**
M2 is related to **motor2.**

1 ***RUN LOW POWER TEST (EPR)*** to eventually discover faults on GRF (in case of MAS configuration) or motor current sensors

2 ***CHECK*** phase to phase impedance value of the motor (**M1** if the diagnostic message is related to this one, **M2** otherwise), disconnecting it from the motor contactors (or output connection in case of MAS motors)
VERIFY that impedance value are equals amongs phases

5.11. GRF Pump and Fan faults

5.11.1. Description

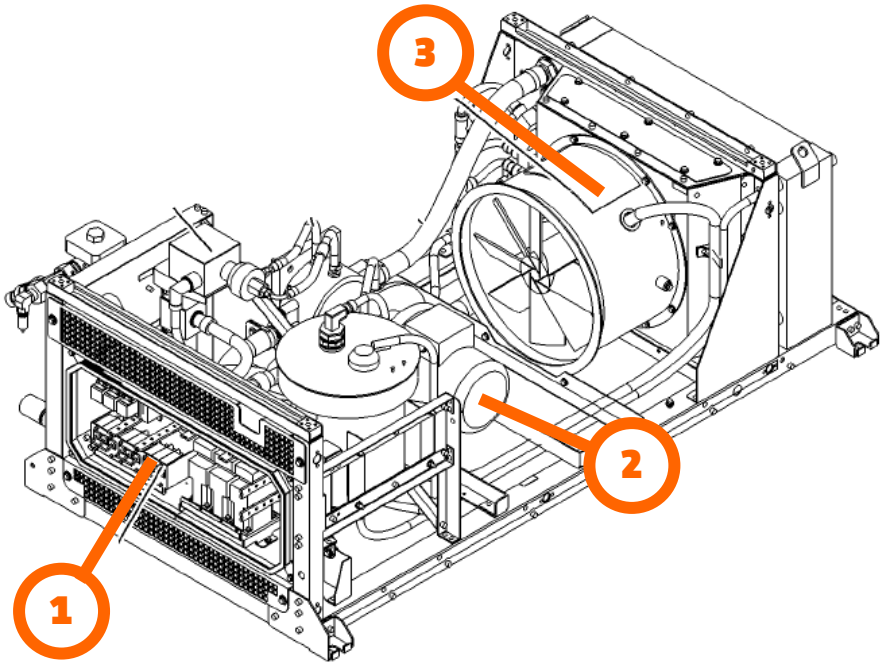
Different protective actions are taken into account in case of fault of the water pump or motor fan of the GRF.
Without water cooling (pump not running, or water pressure low) Traction Unit will be locked; if pump or fan is always running (i.e. due to a stucked relay), a warning message is recorded.
Without air cooling, a warning condition is recorded.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-2C		Warning	GRF cooling pump or fan contactors stuck
xx-27-2D		Lock	GRF cooling pump contactor unabletoclose
xx-27-3C		Warning	GRF cooling fan unable to start
xx-27-3D		Warning	GRF cooling fan unable to pass in hi spd

5.11.2. Involved LRUs

GRF Subsystem is fully tested by the Low Power Test specific sequence presented in 4.3.
Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	Thermal protection (moto-pump)	**RM-11K3**
	Three phase contactor for pump	**11K3**
	Thermal protection (moto-fan PV)	**RM-11K2**
	Three phase contactor	**11K2**
	Thermal protection (moto-fan GV)	**RM-11K1**
	Three phase contactor	**11K1**
2	MOTOR PUMP	**11M3**
3	MOTOR FAN	**11M2**
-	AGATE	**AC3mini**

5.11.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to verify the specific fault on the GRF subsystem

5.12. GRF water pressure, water level

5.12.1. Description

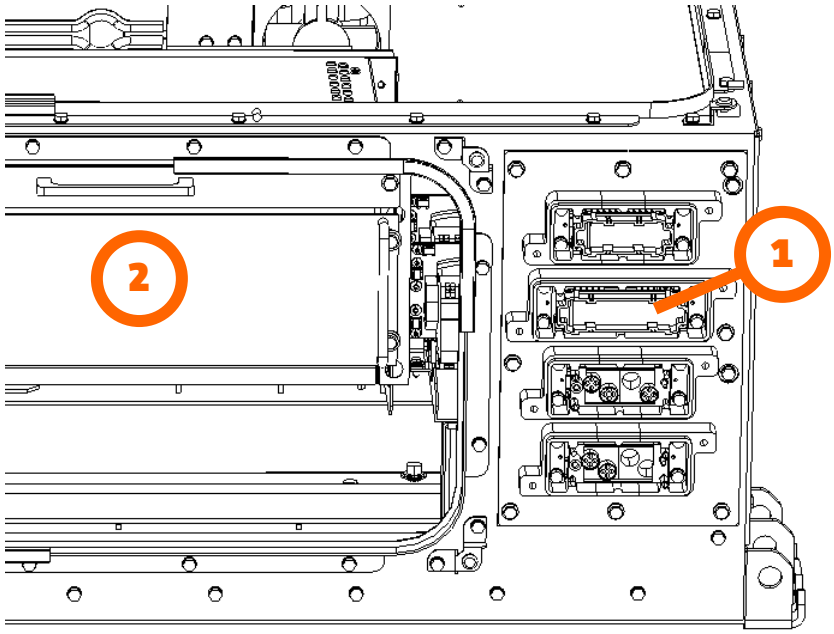
Water pressure of the motor cooling circuit is monitored using a proper pressure transducer.
In case of low water pressure the Traction Unit is locked to prevent more serious troubles at the motors.
Water tank level is optionally acquired when the GRF unit is equipped with these sensors.
In case of low level, a warning message is recorded, preventing system restart.

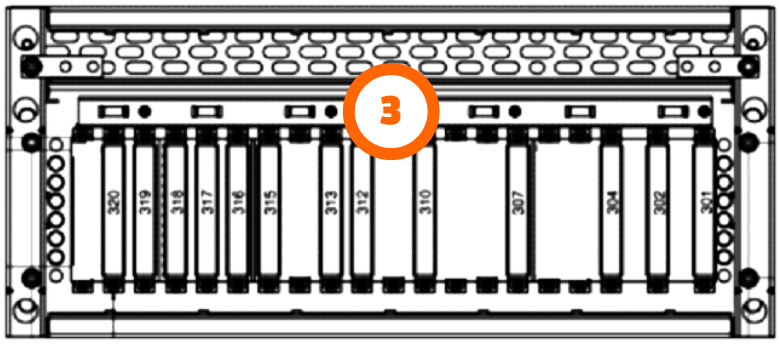
Here below the involved messages.

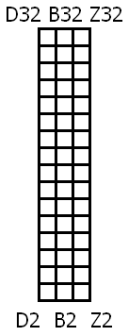
TrainTracerCode		Stack	Text message
xx-27-2E		Lock	GRF cooling water low pressure
xx-27-2A		Warning	GRF cooling water low level

5.12.2. Involved LRUs

5.12.2.1.TBCU

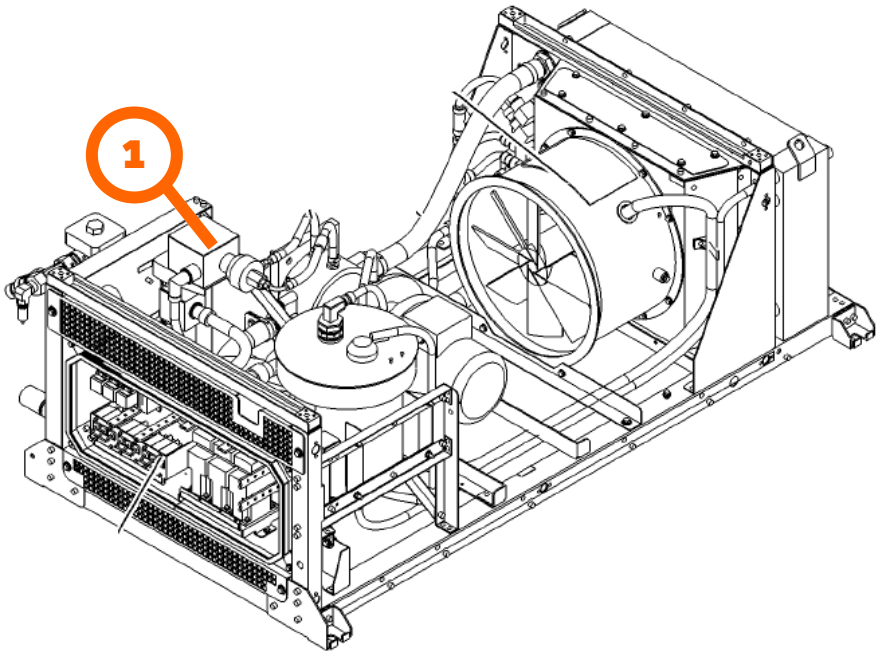






POS	Description	
1	BT connector	**X21**
2	AGATE	**AC3mini**
3	AGATE backplane layout	

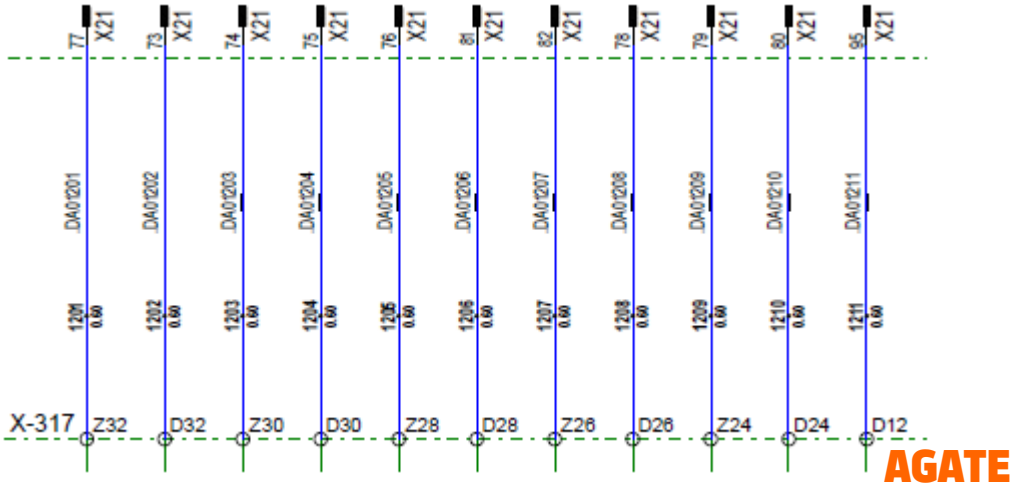
5.12.2.2.GRF



POS	Description	
1	Differential pressure switch	**11B1**
-	Level detector 2 thresholds (option)	**11B6**

5.12.2.3.TBCU LV Scheme

Name	Description	notes	X21
L_PRESSOSTAT	Water pressure sensor from GRF	Active low (open circuit with low pressure)	77
L_WATERLVL1	Water level from GRF	Active low (open circuit with low level)	81
L_WATERLVL2	Water level from GRF	Active low (open circuit with low level)	82



5.12.2.4.Winscope / Traintracer TDB

Use **AutotestGRF.tdb** to support investigation.
Follow on-screen notes in order to:

- Verify weter pressure acquisition while pump is running
- Verify water level acquisition

5.12.3. Verifications

In case of **cooling water low pressure** do the following steps :

1 ***CHECK*** that the GRF water tank is filled correctly

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the water pressure is correctly acquired running the water pump

3 ***CHECK*** the cabling removing the Agate, from the Agate backplane to the GRF unit
VERIFY that electrical connections are good

4 ***REPLACE*** pressure switch **11B1**
VERIFY that the water pressure is correctly acquired running the water pump

In case of **GRF cooling water low level** do the following steps :

1 ***CHECK*** that the GRF water tank is filled correctly

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the water levels are correctly acquired

3 ***CHECK*** the cabling removing the Agate, from the Agate backplane to the GRF unit
VERIFY that electrical connections are good

4 ***REPLACE*** level switch **11B6**
VERIFY that the water pressure is correctly acquired running the water pump

5.13. GRF water high temperature and temperature incoherence

5.13.1. Description

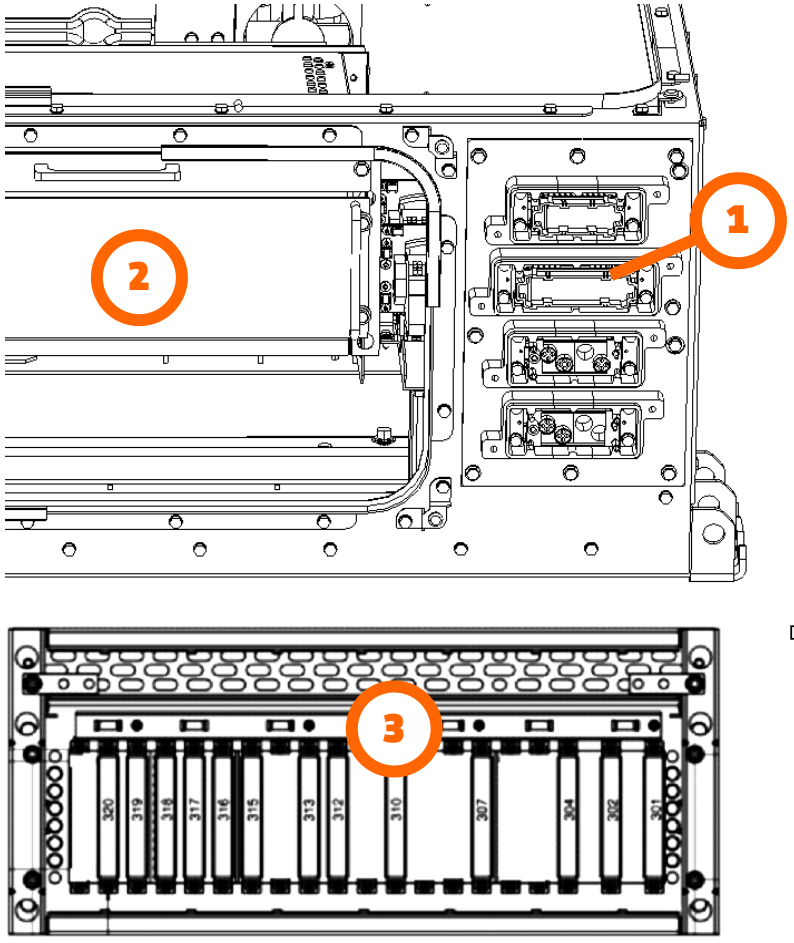
Water temperature of the motor cooling circuit is monitored using proper thermoswitches (31°C, 85°C, two reduntant 105°C).
Only repetitive water overtemperature (triggered when two amongs three high temp thermoswitches are active) will lock the Traction System.
Before that, a torque reduction is request to prevent completely loss of traction capabilities.
If an inconsistency temperature information is acquired (85°C is detected, 31°C not), a message is recorded to highlight this anomalous behavior of the temperature sensors.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-2B		Warning	GRF cooling water high temperature 85
xx-27-2F		Error	GRF cooling water very high temperature
xx-27-30		Lock	GRF repetitive water very high temp
xx-27-3E		Message	GRF water temperature incoherence

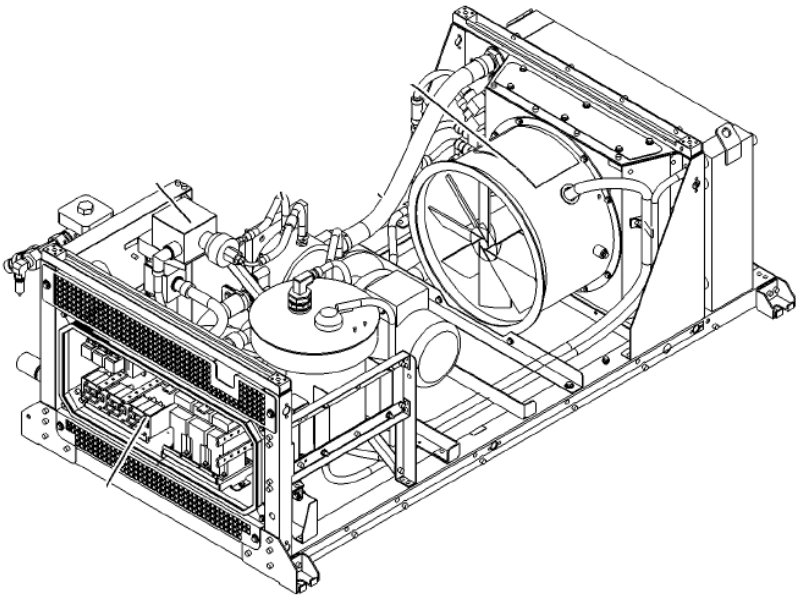
5.13.2. Involved LRUs

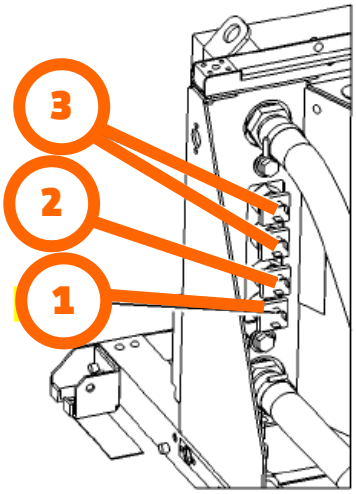
5.13.2.1.TBCU



POS	Description	
1	BT connector	**X21**
2	AGATE	**AC3mini**
3	AGATE backplane layout	

5.13.2.2.GRF

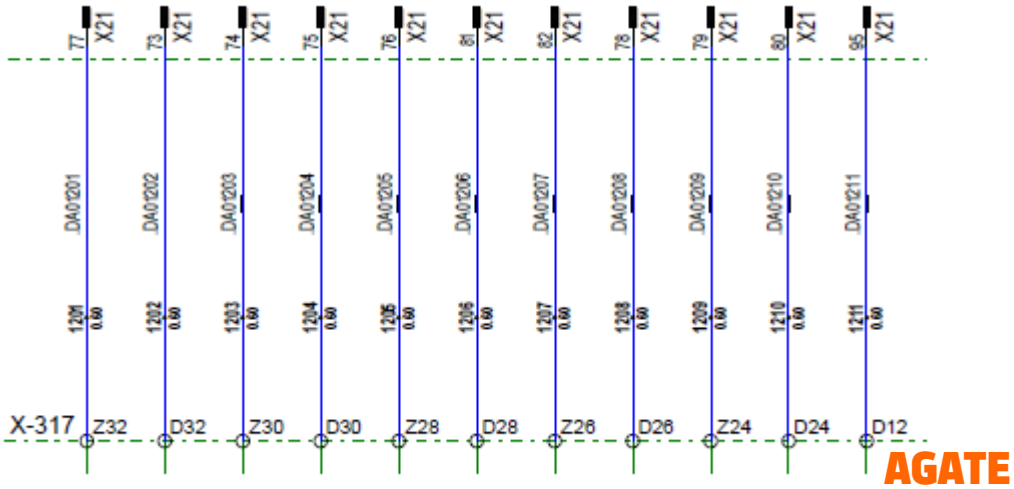




POS	Description	
1	Thermostat 31°C	**11B5**
2	Thermostat 85°C	**11B4**
3	Thermostat 105°C	**11B2, 11B3**

5.13.2.3.TBCU LV Scheme

Name	Description	notes	X21
L_TEMP31	Temperature sensor from GRF	Active high (+BAT when T>31)	73
L_TEMP85	Temperature sensor from GRF	Active high (as above)	74
L_TEMP105	Temperature sensor from GRF	Active high (as above)	75
L_TEMP105_2	Temperature sensor from GRF	Active high (as above)	76



5.13.2.4.Winscope / Traintracer TDB

Use **AutotestGRF.tdb** to support investigation.
Follow on-screen notes in order to:

- Check correct water temperature acquisition

5.13.3. Verifications

In case of **GRF water temperature incoherence** do the following steps :

1 ***CHECK*** all temperature signals when traction converter is off (no HV present, just the Agate is switched on)
VERIFY that no incoherence exists at standstill (temp85=true but temp31=false), otherwise ***REPLACE*** **AC3mini,** downloading the correct Traction SW version, and check again temperature informations

2 ***CHECK*** the cabling removing the Agate, from the Agate backplane to the GRF unit
VERIFY that electrical connections are good

3 ***REPLACE*** termostat switch **11B1**
VERIFY that temp85=FALSE when traction converter is off

In case of **GRF repetitive water very high temp** do the following steps :

1 ***CHECK*** that GRF water tank is filled correctly

1 ***CHECK*** all temperature signals when traction converter is off (no HV present, just the Agate is switched on)
VERIFY that the water levels are correctly acquired

3 ***CHECK*** the cabling removing the Agate, from the Agate backplane to the GRF unit

4 ***REPLACE*** level switch **11B6**
VERIFY that the water pressure is correctly acquired running the water pump

5.14. Motor overspeed fault

5.14.1. Description

When the measured motor speed exceeds a specific overspeed threshold, a warning event is recorded in the diagnostic memory; in case of repetitive fault, this occurrence of events is condidered a severe fault which lock the Traction System.
The overspeed threshold is used to protect the motor against possible mechanical damages, at its value is above the maximum vehicle speed allowed.

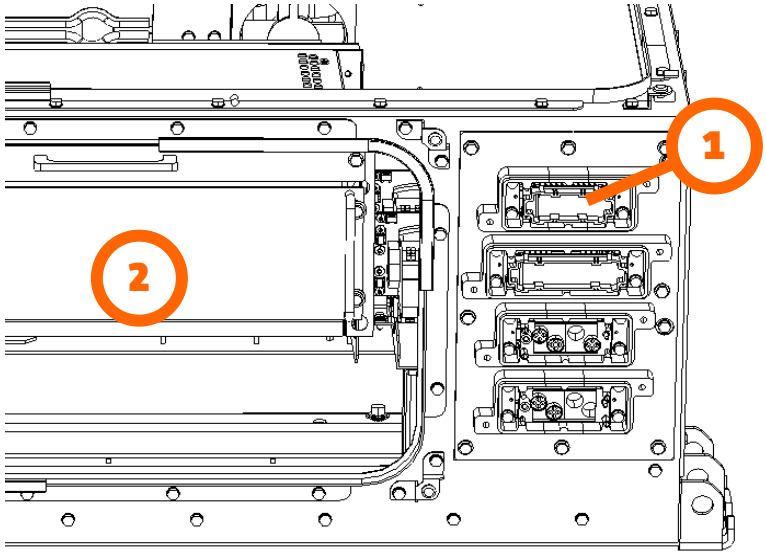
Here below the involved messages.

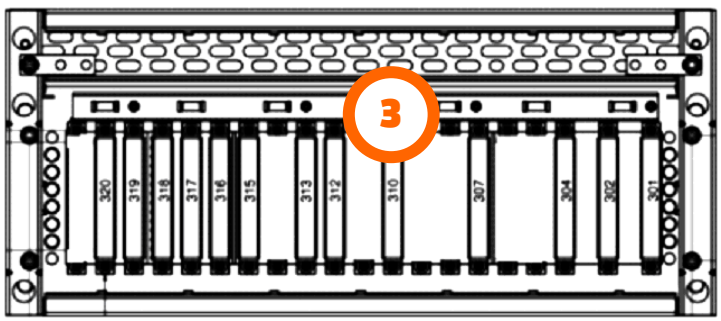
TrainTracerCode		Stack	Text message
xx-27-32	M1	Warning	Motor overspeed
xx-2B-1A	M2		
xx-27-33	M1	Lock	Repetitive motor overspeed
xx-2B-1B	M2		

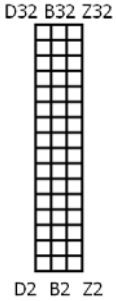
5.14.2. Involved LRUs

5.14.2.1.TBCU

Motor speed sensors are tested by the Low Power Test specific sequence presented in 4.7.
Please refer to it for all the details related to LV schemes and WinScope TDB.

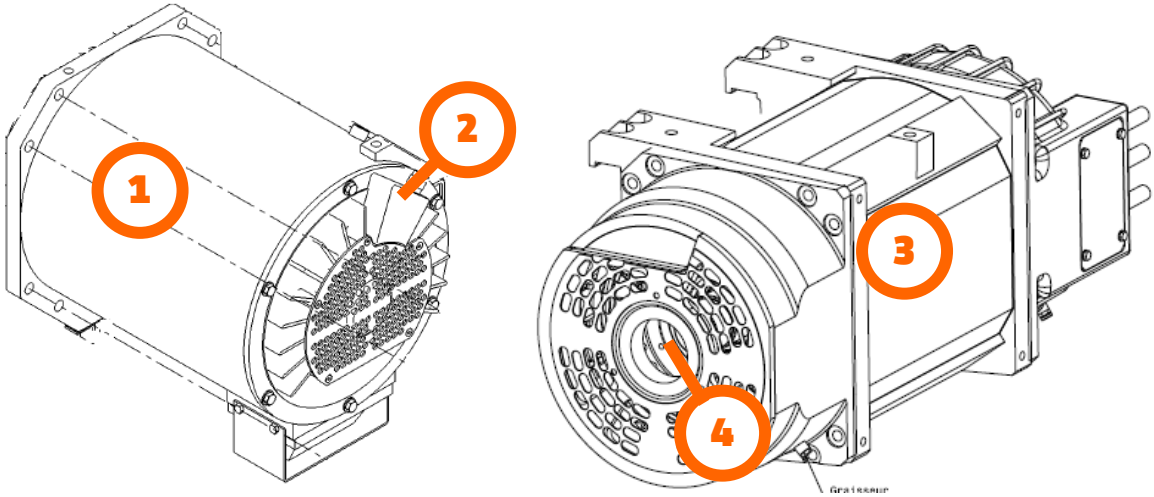






POS	Description	
1	BT connector	**X20**
2	AGATE	**AC3mini**
3	AGATE backplane layout	

5.14.2.2.Motors



POS	Description	
1	MAS motor 4HGA1433	**M1, M2**
2	Speed sensor - RH1522	
3	PMM motor 6LMS1052	**M1, M2**
4	Synchro-resolver	

5.14.3. Verifications

Even if the text messages are generic, the TrainTraceCode permits to identify which motor is supposed to have troubles, as on the table presented before.
M1 is related to **motor1.**
M2 is related to **motor2.**

1 ***RUN LOW POWER TEST (EPR)*** to discover possible faults on speed sensors

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that no specific faults are recorded while performing a dynamic test

3 ***REPLACE*** the supposely fault speed sensor / resolver
VERIFY that no specific faults are recorded while performing a dynamic test

5.15. Inverter cooling fan fault

5.15.1. Description

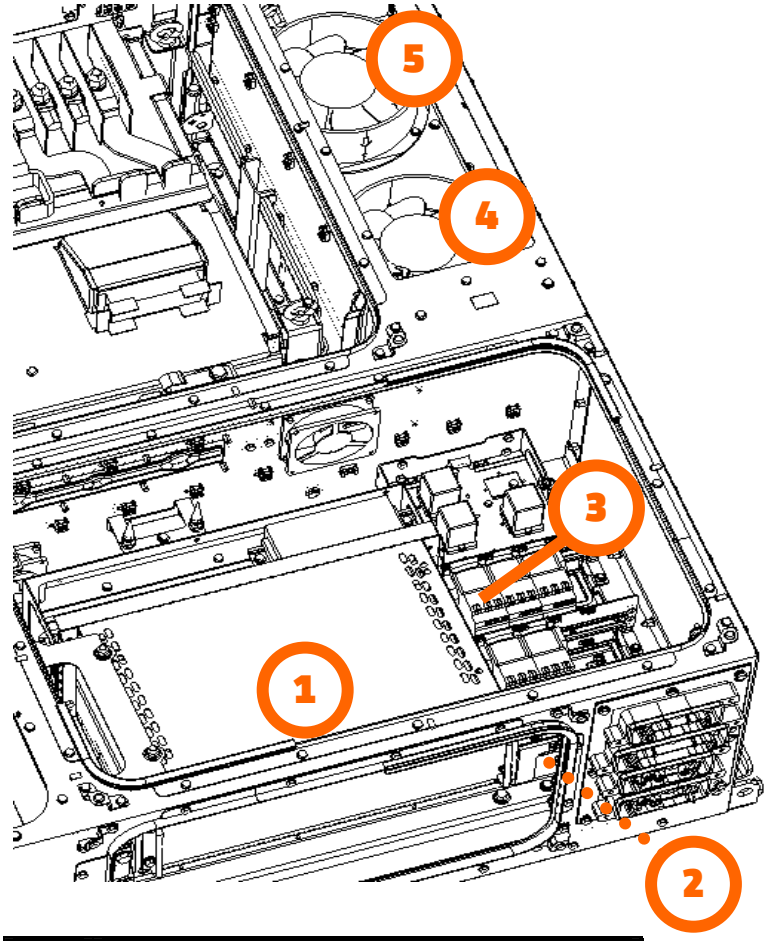
Power module cooling fans are essential for proper functionalities of the Traction Converter.
Without cooling, Traction System is considered locked in order to avoid seriuos damages to the power module.
A less severe fault is when it is not possible to stop fans (i.e. due to a stuck condition of the contactor K4).

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-35	I1	Warning	Inverter cooling fan stuck
xx-2B-1D	I2		
xx-27-36	I1	Lock	Inverter cooling fan unable to start
xx-2B-1E	I2		

5.15.2. Involved LRUs

Power module cooling fans are fully tested by the Low Power Test specific sequence presented in 4.4.
Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	AGATE	**AC3mini**
2	Fan speed control board	**FSCB**
3	LV contactor LC1D126BLS170	**K4**
4	Power module fan (MF)	**M1PM**
5	Power module fan (MF)	**M2PM**

5.15.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to verify the specific fault on the power module cooling system

5.16. Inverter overtemperature

5.16.1. Description

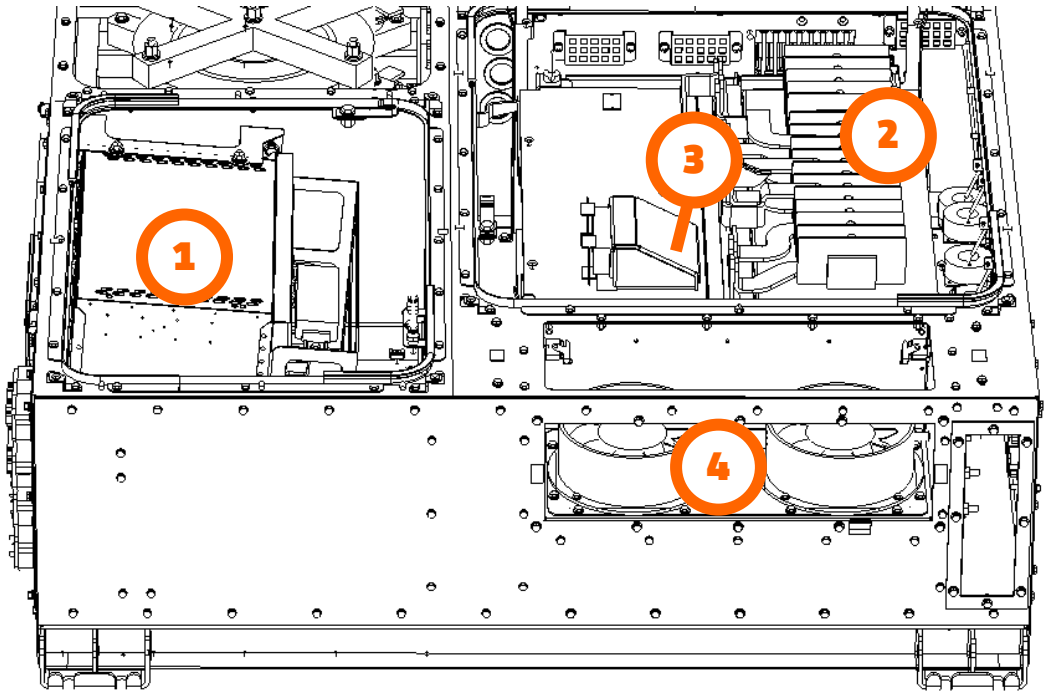
Power module is monitored by proper thermoswitches installed on the heat-sink.
When the thermoswitch detects an anomalous overtemperature condition, a warning event is traced in the diagnostic memory, and cooling fans are forced to run at high speed (even if the vehicle is in standstill).
If this condition persists for more than 60sec, an error is traced and the traction converter is switched-off until the error condition disappears.
In case of repetitive overtemperature faults, the system is locked due to a severe fault.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-34	I1	Warning	Inverter overtemperature
xx-2B-1C	I2		
xx-27-37	I1	Error	Inverter overtemperature
xx-2B-1F	I2		
xx-27-38	I1	Lock	Repetitive inverter overtemperature
xx-2B-20	I2		

5.16.2. Involved LRUs

Power module thermoswitches are tested by the Low Power Test specific sequence presented in 4.5.
Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	AGATE	**AC3mini**
2	Power module ONIX850DLP3	**ONIX850DLP3**
3	Power module BT connector	**X30**
4	Power module fans	**M1PM, M2PM**

5.16.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to verify the thermoswitches status at standstill, and the correct functionality of the power module fans

2 ***CHECK*** visually the power module cooling fans
VERIFY that no obstruction exist that could reduce air flow

3 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that no specific faults are recorded while performing a dynamic test

5.17. BCU related faults

5.17.1. Description

Each traction unit controls the BCU (mechanical brake control unit) related to its own motorized bogie.
Mechanical brake effort setpoint is provided through 4 digital outputs (16 possible effort levels).
BCU provides to Traction a feedback for brake applied and brake release (2 digital inputs which commutates at a predefined effort level); these signals are used for diagnostic control.
Finally, at train level a specific LV circuit permits to control mechanical brake through TCMS when Traction Unit is in fault; this is done by a bypass relay, part of train scheme but controlled by Traction, plus the related auxiliary contact used for diagnostic.

When inconsistency is detected :

- between effort setpoint and feedback
- or between bypass relay command and aux contact feedback

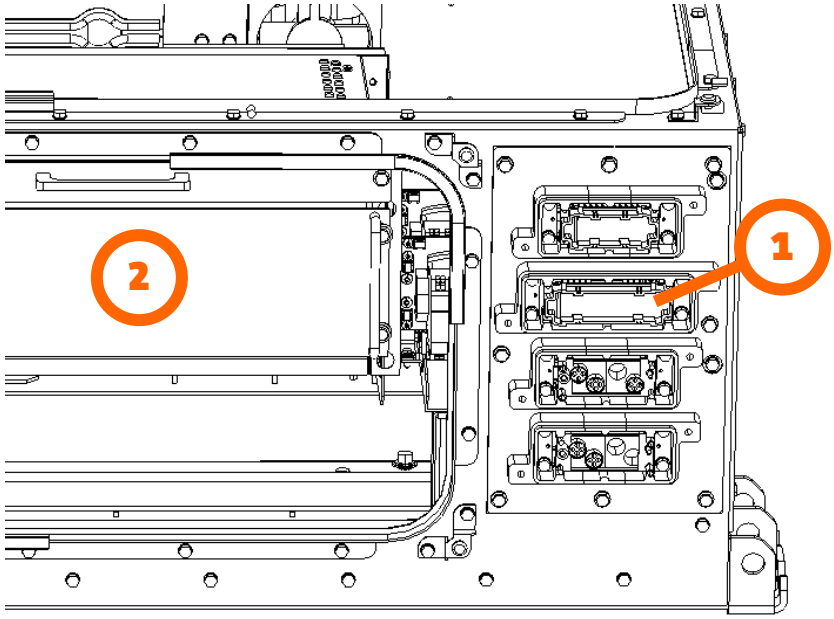
Mechanical Brake control pass to TCMS, until the end of the braking phase. At standstill, Traction try to reset this fault; in case of repetitive faults in a certain time, mech brake is considered out-of-order and controls pass definitively to TCMS (Agate must be switched-off to recover this fault).

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-50		Message	Fault on BCU relay auxiliary contact
xx-27-52		Message	Fault on BCU brake applied feedback
xx-27-57		Message	Fault on BCU brake released feedback
xx-27-58		Message	Repetitive fault on BCU

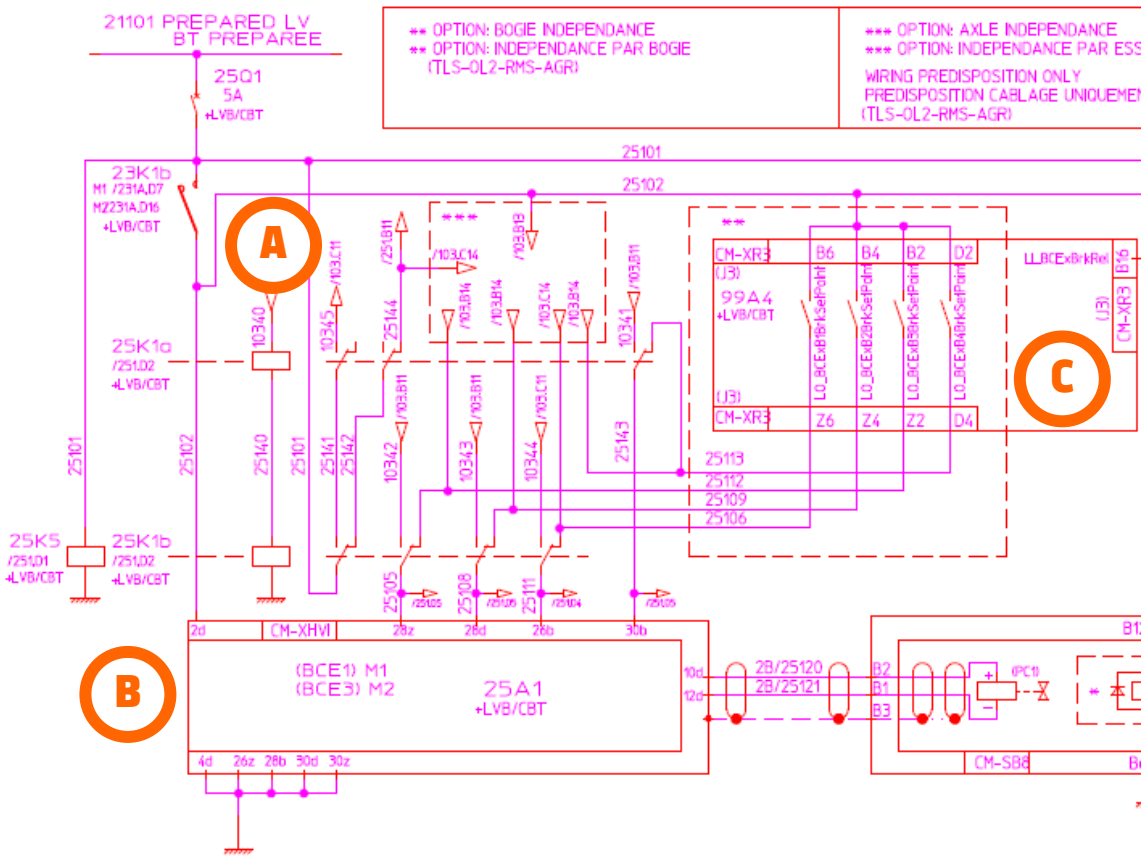
5.17.2. Involved LRUs

5.17.2.1.TBCU



POS	Description	
1	BT connector	**X21**
2	AGATE	**AC3mini**

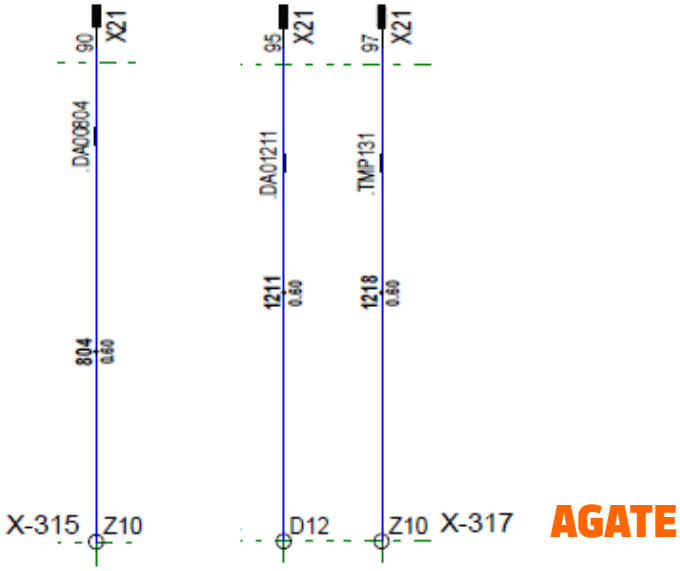
5.17.2.2.Train LV Scheme



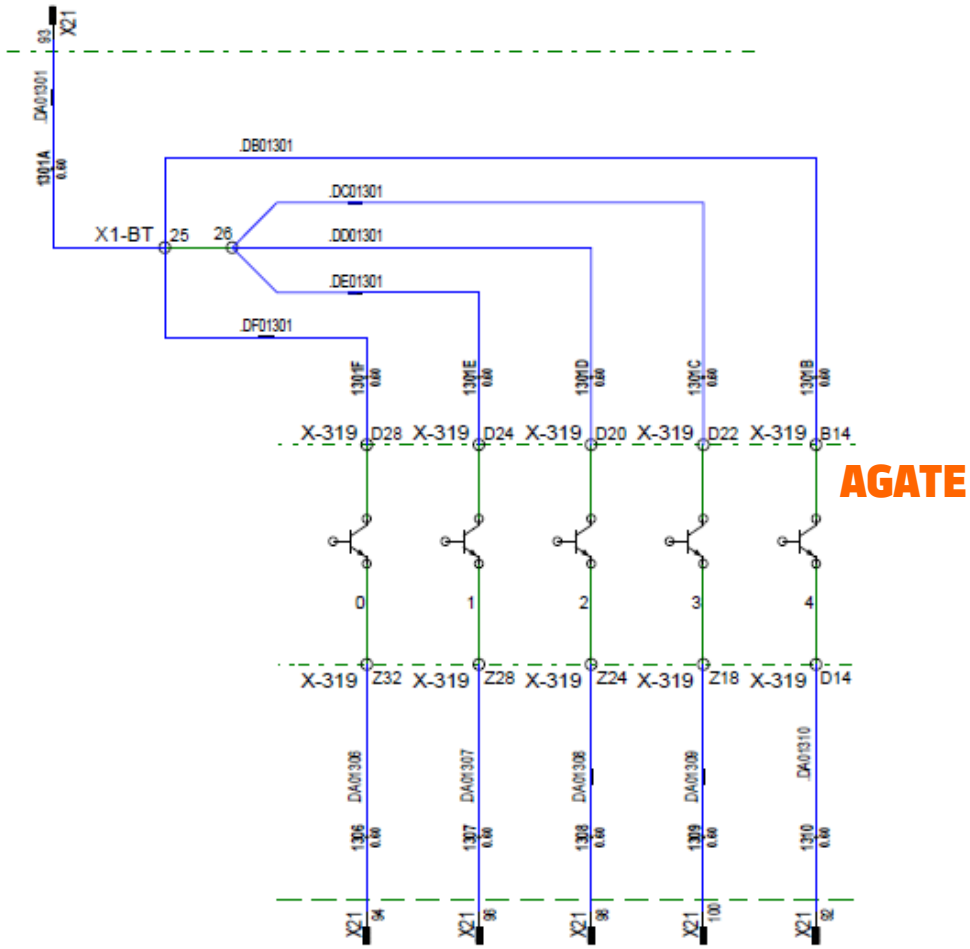
A. Bypass relay (controlled by Traction) used to take 4 setpoint signals from Traction or TCMS
B. BCU Unit
C. TCMS RIOM redundant to Traction digital outputs

5.17.2.3.TBCU LV Scheme

Name	Description	notes	X21
L_BCURELAY	Aux contact from BCU bypass relay	Active high	90
L_BCUAPP	Mech brake applied from BCU	Active high	95
L_BCUREL	Mech brake released from BCU	Active high	97



Name	Description	notes	X21
LO_BCURELAY	Command to control BCU relay. Internally connected to L_BCU_BAT	**Static** output. Close circuit in order to energize external BCU relay	92
LO_LOCBR0	Command for BCU. Internally connected to BCU_BAT.	**Static** output.	94
LO_LOCBR1	Command for BCU.	**Static** output.	96
LO_LOCBR2	Command for BCU.	**Static** output.	98
LO_LOCBR3	Command for BCU.	**Static** output.	100
BCU_BAT	1 pin to energize static output for BCU		93



5.17.2.4.Winscope / Traintracer TDB

Use **MechBrake.tdb** to support investigation.
Follow on-screen notes in order to:

- Force setpoint to the mechanical brake
- Check correct feedback signals
- Check proper functionalities of the Bypass external Relay 25K1

5.17.3. Verifications

In case of **Fault on BCU relay auxiliary contact** do the following steps :

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY correct functionality of the external bypass relay 25K1 using the specific winscope TDB

2 ***CHECK*** the cabling from the Agate backplane to the X21 connector, then to the external relay
VERIFY that electrical connections are good

2 ***REPLACE*** external relay the cabling from the Agate backplane to the X21 connector, then to the external relay
VERIFY correct functionality of the external bypass relay 25K1 using the specific winscope TDB

In case of **Fault on BCU brake applied feedback** do the following steps :

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY correct feedback of L_BCUAPP signal using the specific winscope TDB

2 ***CHECK*** the cabling from the Agate backplane to the X21 connector, then to the external BCU
VERIFY that electrical connections are good

3 ***REPLACE*** BCU device
VERIFY correct feedback of L_BCUAPP signal using the specific winscope TDB

In case of **Fault on BCU brake released feedback** do the following steps :

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY correct feedback of L_BCUAPP signal using the specific winscope TDB

2 ***CHECK*** the cabling from the Agate backplane to the X21 connector, then to the external BCU
VERIFY that electrical connections are good

3 ***REPLACE*** BCU device
VERIFY correct feedback of L_BCUREL signal using the specific winscope TDB

5.18. DC Current sensors offset fault

5.18.1. Description

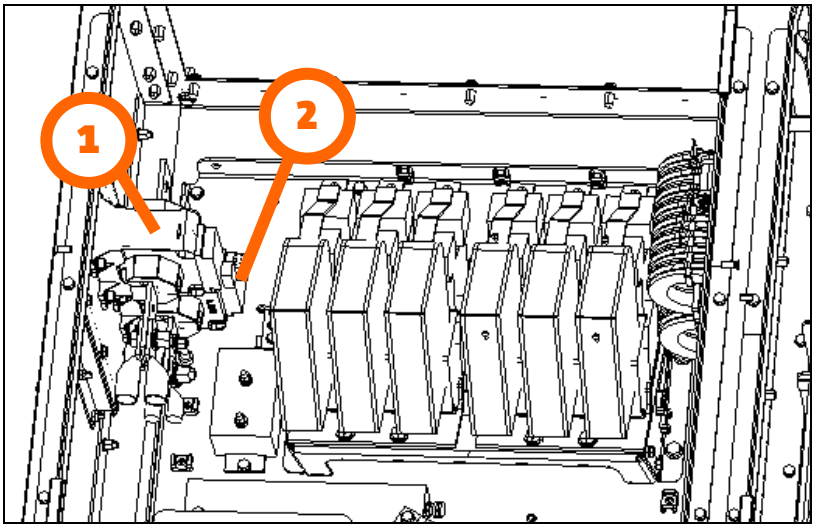
DC current sensors are monitored for offset errors.
When the line and precharge contactors are open, a current value measured above a threshold is considered an offset error; this condition lock the Traction System for maintenance verifications.

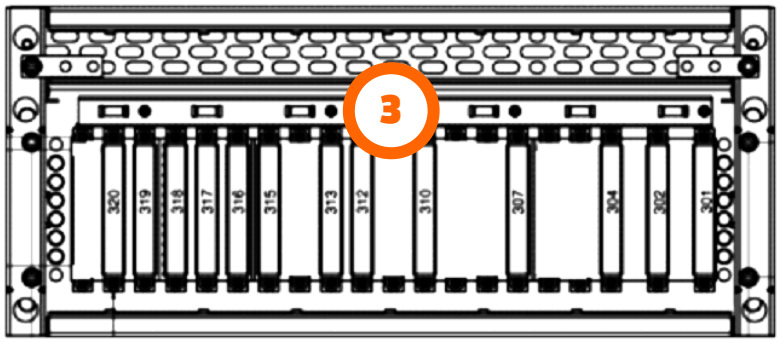
Here below the involved messages.

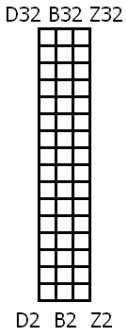
TrainTracerCode		Stack	Text message
xx-27-74		Lock	DC current positive sensor offset error
xx-27-75		Lock	DC current negative sensor offset error

5.18.2. Involved LRUs

Current sensors offset are fully tested by the Low Power Test specific sequence presented in 4.6.
Please refer to it for all the details related to LV schemes and WinScope TDB.







POS	Description	
1	Line current sensor	TAL_P1
2	Line current sensor	TAL_N1
3	AGATE backplane layout	

5.18.3. Verifications

1 ***RUN LOW POWER TEST (EPR)*** to discover possible faults on DC current transducers

5.19. Motor currents faults

5.19.1. Description

Motor current sensors are monitored in order to detect anomalous values, in particular unexpected low current values when motor is running, or unbalance currents between phases.
When the anomalous behavoir appears, the Traction System is stopped for a while, then it restart automatically. In case of repetitive occurrences, the system is locked for maintenance and will requires a maintenance check.

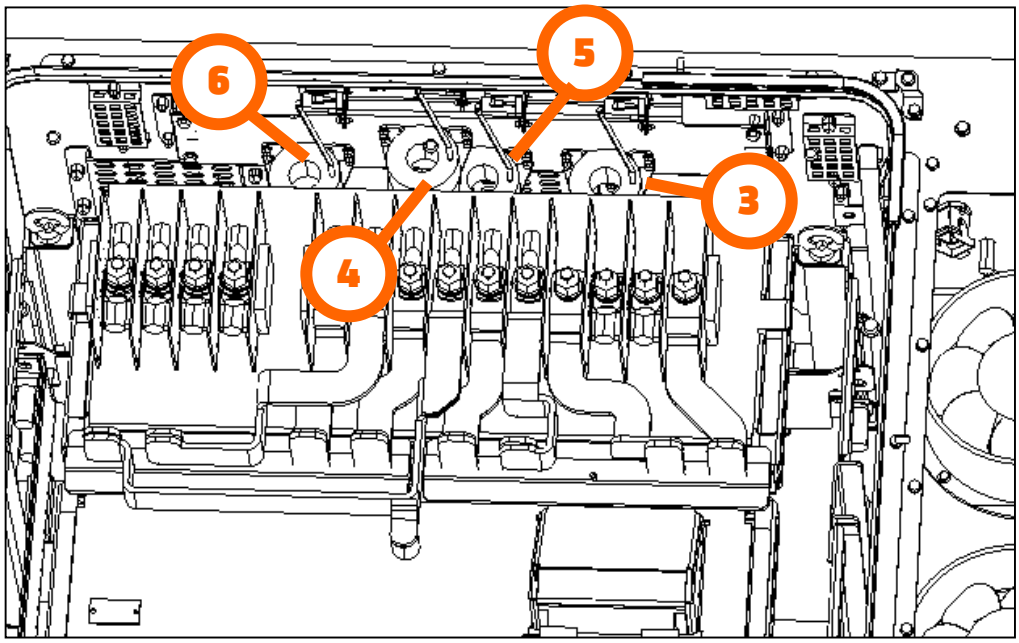
Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-7B	M1	Error	Unexpected low motor curr when running
xx-2B-63	M2		
xx-27-7C	M1	Lock	Repetitive low motor curr when running
xx-2B-64	M2		
xx-27-7E	M1	Error	Motor current unbalance
xx-2B-66	M2		
xx-27-7F	M1	Lock	Motor current unbalance repetitive fault
xx-2B-67	M2		
xx-27-7D	M1	Lock	Motor current sensor fault
xx-2B-65	M2		

5.19.2. Involved LRUs

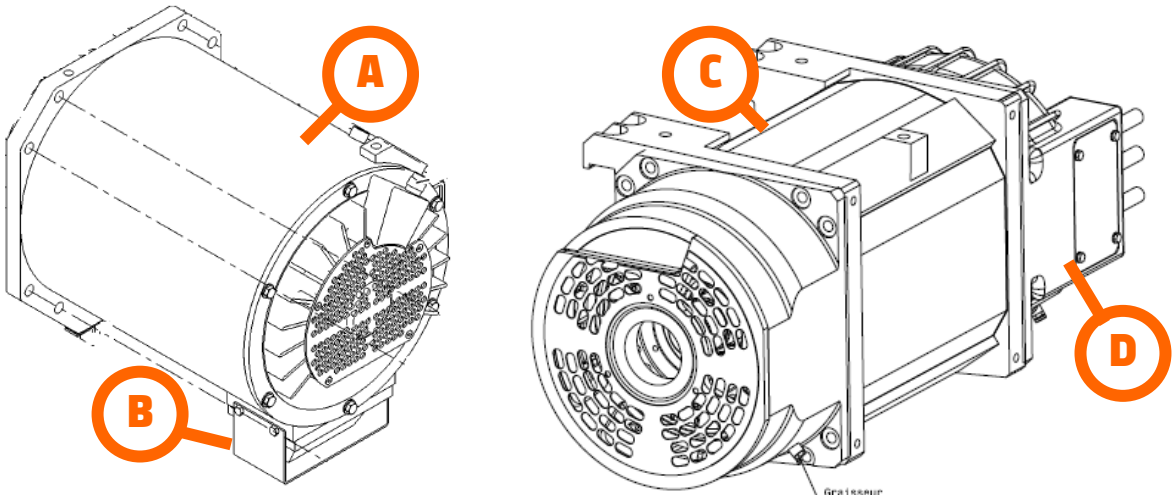
5.19.2.1.TBCU

Motor current sensors are tested by the Low Power Test specific sequence presented in 4.6.
Please refer to it for all the details related to LV schemes and WinScope TDB.



POS	Description	
1	Motor phase current sensor	**TAM_U1**
2	Motor phase current sensor	**TAM_V1**
3	Motor phase current sensor	**TAM_U2**
4	Motor phase current sensor	**TAM_V2**
	AGATE	**AC3mini**

5.19.2.2.Motors



POS	Description	
A	MAS motor 4HGA1433	**M1, M2**
B	MAS motor electrical connections	
C	PMM motor 6LMS1052	**M1, M2**
D	PMM motor electrical connections	

5.19.3. Verifications

In case of **Motor current sensor fault** (which appears when measured current is not zero with pulses inhibited) do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to verify possible offset faults of the motor current transducers

In case of **Motor current unbalance repetitive fault** (which appears when phase currents are not balanced correctly) do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to verify possible offset faults of the motor current transducers

2 ***CHECK*** phase to phase impedance value of the motor (**M1** if the diagnostic message is related to this one, **M2** otherwise), disconnecting it from the motor contactors (or output connection in case of MAS motors)
VERIFY that impedance value are equals amongs phases

In case of **Repetitive low motor curr when running** (which appears when measured currents is unexpected low while motor is running) do the following steps :

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test

2 ***CHECK*** motor current sensors acquisition while performing a dynamic test
VERIFY which sensor detects anomalous low current, and **REPLACE** it

3 ***CHECK*** the cabling between the rack backplane rack and the motor current sensors
VERIFY that electrical connections are good

5.20. Precharge sequence faults

5.20.1. Description

Precharge phase (the usual way to energize the DC filter before starting the power module) is monitored for faults or erroneous behaviors:

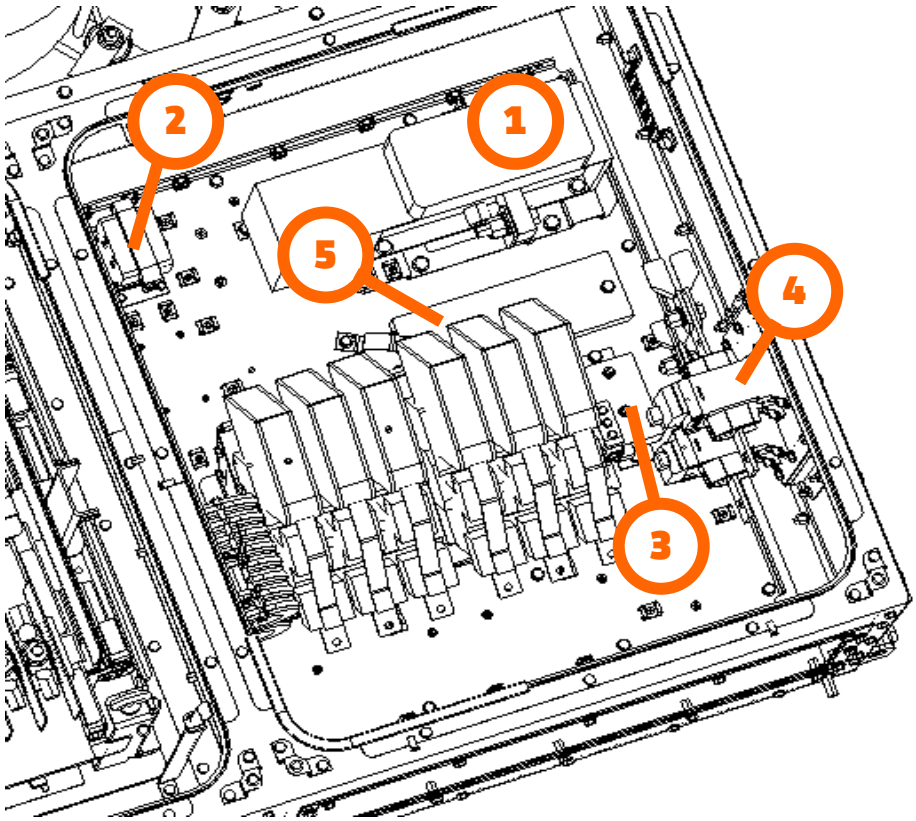
- Faults of the contactors (line and precharge)
- Unexpected rising time of the voltage (too long)
- Overtemperature of the precharge resistor (monitored via a thermal model)

Here below the involved messages.

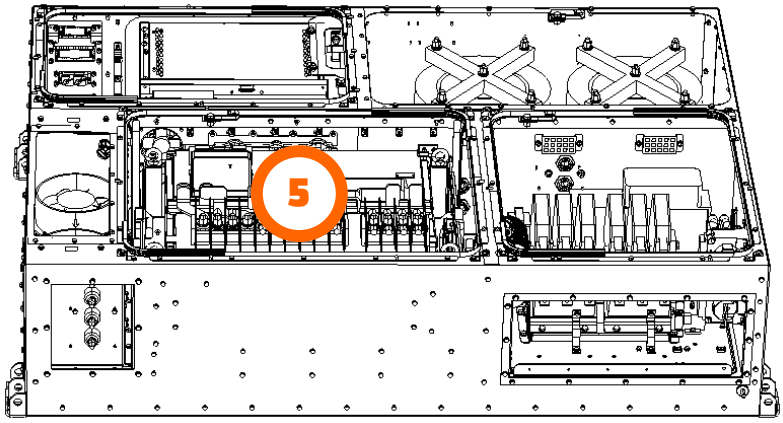
TrainTracerCode		Stack	Text message
xx-27-1E		Error	Precharge sequence fault
xx-27-1F		Lock	Repetitive precharge sequence fault
xx-27-93		Message	Precharge time too long
xx-27-94		Message	Precharge resistor overtemperature

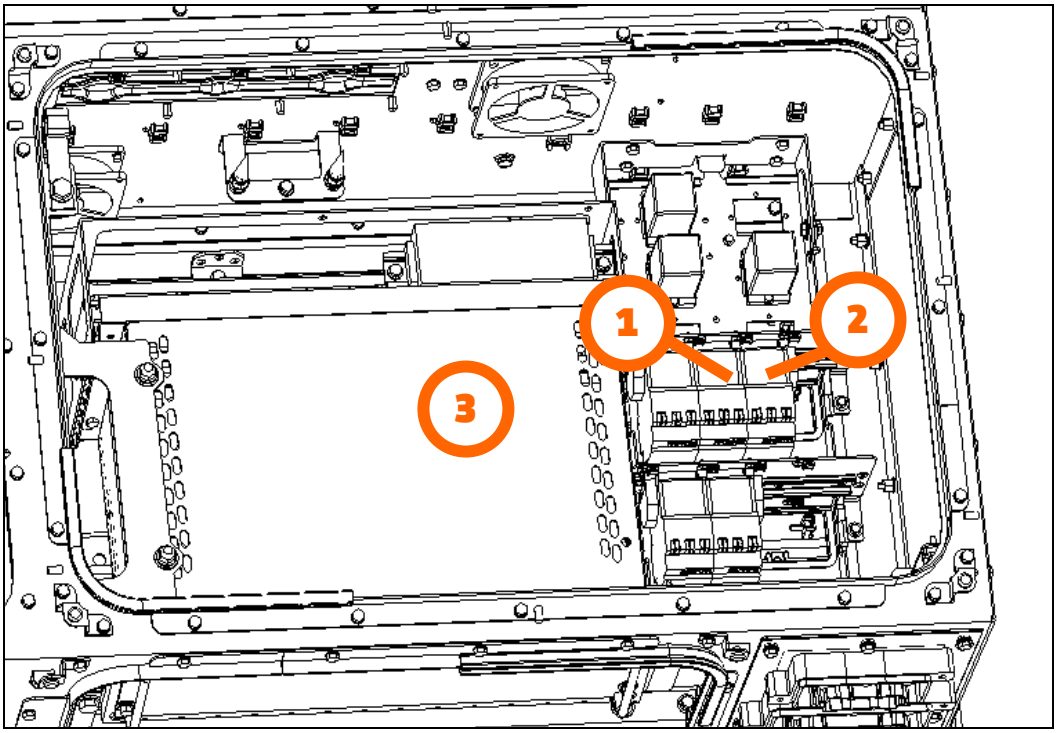
5.20.2. Involved LRUs

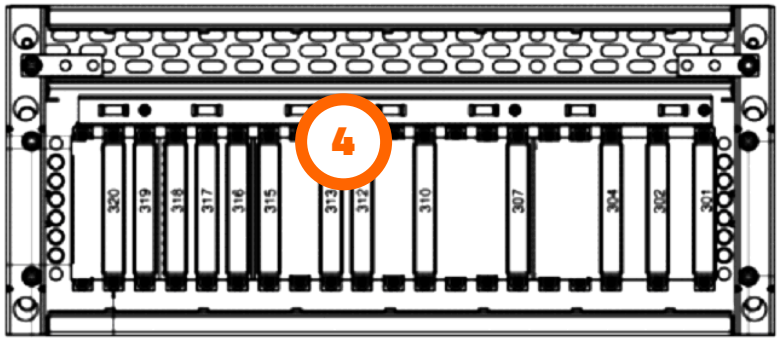
Precharge sequence is tested by the Low Power Test specific sequence presented in 4.8.
Please refer to it for all the details related to LV schemes and WinScope TDB.

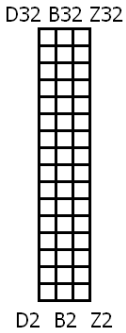


POS	Description	
1	Line contactor Sécheron	**KL1**
2	Precharge contactor LTC100	**KPRE1**
3	Line voltage sensor AV100-1000/SP2	**TVL1**
4	Line current sensor	**TAL_P1**
5	Precharge resistor 30 OHMS 280W	**RPRE1**









POS	Description	
1	LV contactor LC1D126BLS170	**K5**
2	LV contactor LC1D126BLS170	**K6**
3	AGATE	**AC3mini**
4	AGATE backplane layout	
5	Power module ONIX850DLP3	**ONIX850DLP3**

5.20.3. Verifications

In case of **Precharge sequence fault** or **Repetitive precharge sequence fault** (which appears when precharge phase is not completed successfully) do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to verify possible faults on the precharge phase

In case of **Precharge resistor overtemperature** (which appears when precharge is overheated, i.e. due to too many precharge operation in a short time) do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to verify possible faults on the precharge phase

2 ***CHECK*** ohmic value of the resistor **RPRE1**
VERIFY that value is around 30ohms

In case of **Precharge time too long** (which appears when precharge phase is not completed successfully) do the following steps :

1 ***RUN LOW POWER TEST (EPR)*** to verify possible faults on the precharge phase

5.21. Power module natural voltage discharge

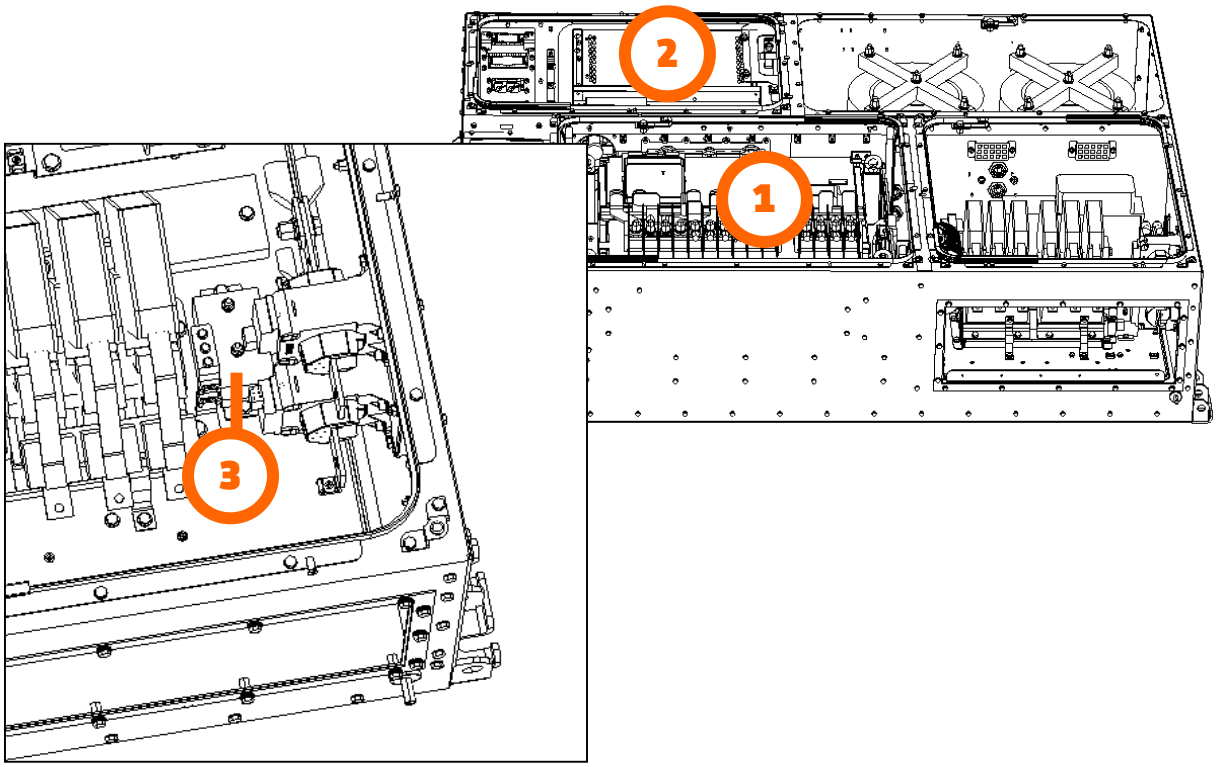
5.21.1. Description

When the line contactor opens (as request by the TCMS, or due to a traction converter internal fault), the DC filter discharges naturally thanks to some internal resistors installed in the power module. This is a safe design solution in order to perform maintenance activities without any risks.
The discharge phase is monitored to detect fault on these resistors: a proper lock message is recorded when the DC voltage is still above 50V, 300sec after the DC bus has been disconnected by the HV line.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-80		Lock	DC Bus discharge time too long

5.21.2. Involved LRUs



POS	Description	
1	Power module ONIX850DLP3	**ONIX850DLP3**
2	AGATE	**AC3mini**
3	Line voltage sensor	**TVL1**

5.21.3. Verifications

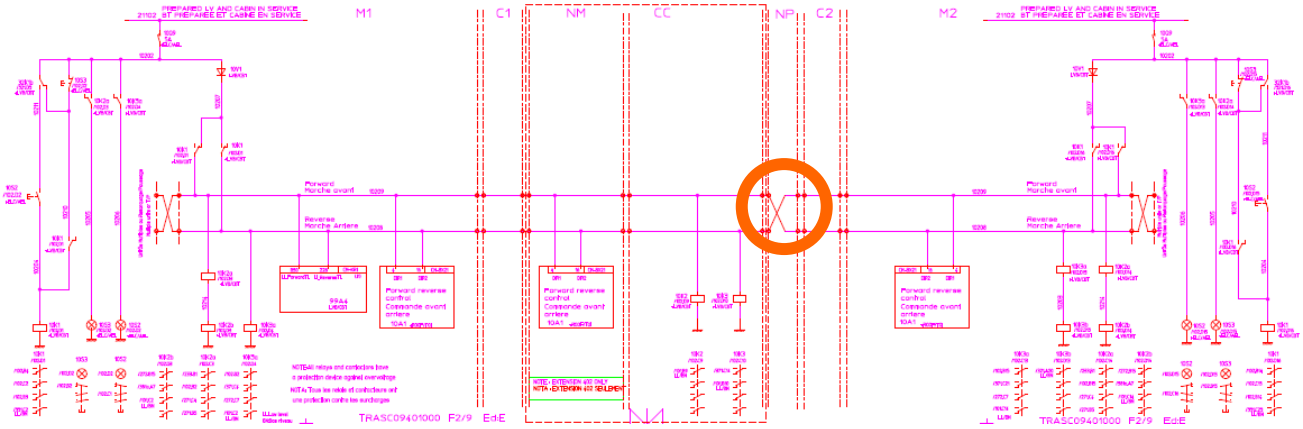
1 ***RUN LOW POWER TEST (EPR)*** to verify possible faults on the precharge phase

2 ***REPLACE*** **ONIX850DLP3**
VERIFY that the low power test sequence is completed successfully

5.22. Direction request

5.22.1. Description

Direction requests comes from proper digital inputs, directly connected to the selector on the driver desk. Due to the traction architecture at train level, direction request are crossed depending on the roof position.



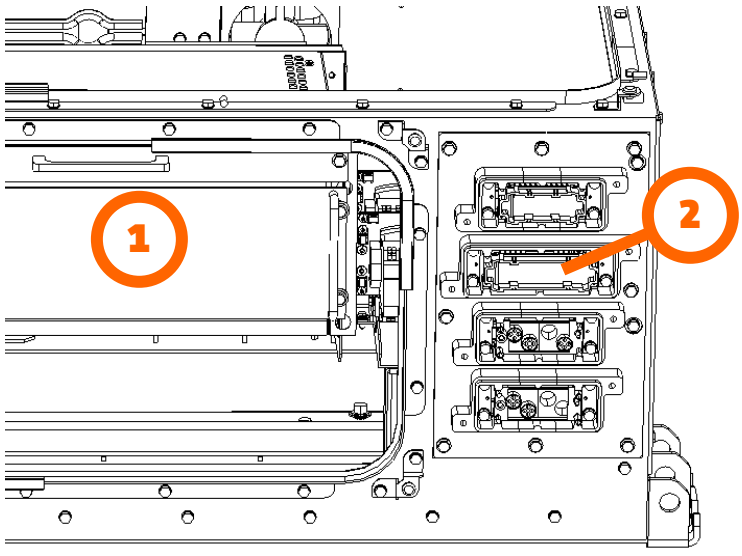
An inconsistent direction requests (both digital inputs cannot be in any case to TRUE at the same time) will generate a warning message. If this anomalous condition persist for more than 20s, a serious fault exists at Train or Traction level, so the Traction Converter is locked because it is unable to correctly decodes direction requests.

Here below the involved messages.

TrainTracerCode		Stack	Text message
xx-27-19		Warning	DIR1 & DIR2 digital inputs both to TRUE
xx-27-1A		Lock	Main DIR error

5.22.2. Involved LRUs

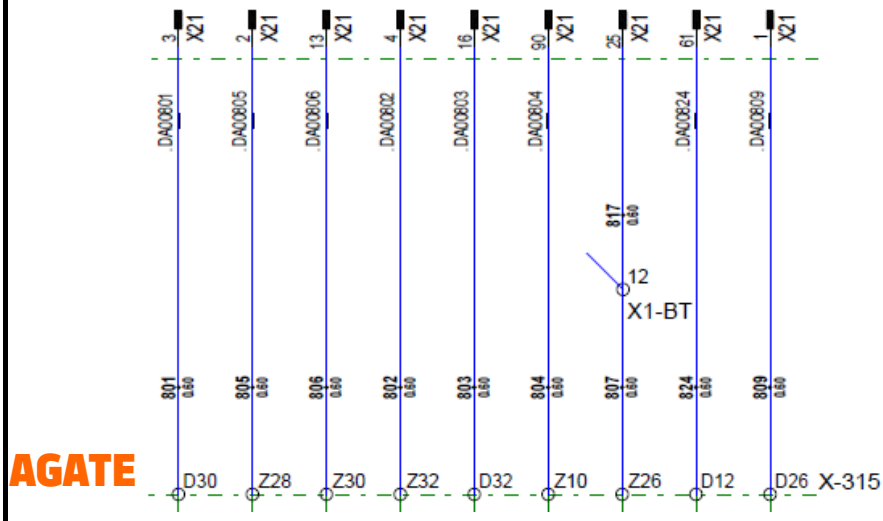
5.22.2.1.TBCU



POS	Description	
1	AGATE	**AC3mini**
2	BT connector	**X21**

5.22.2.2.TBCU LV Scheme

Name	Description	notes	X21
L_DIR1	DIR1 command	Active high	4
L_DIR2	DIR2 command	Active high	16



5.22.3. Verifications

1 ***CHECK*** the cabling between the rack and the X21 connector removing the Agate
VERIFY that electrical connections are good

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the Traction System starts without faults

5.23. Manipulator request

5.23.1. Description

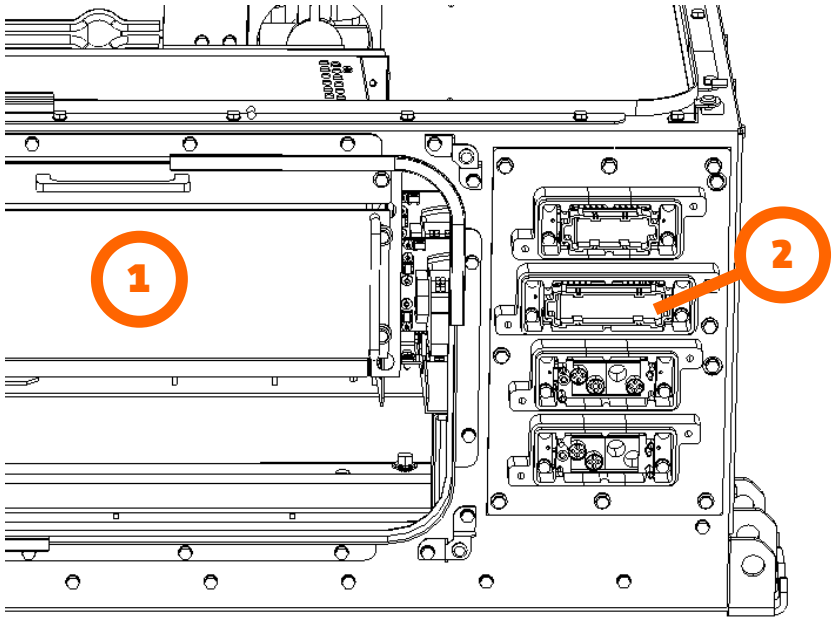
TCMS sends to Traction an electrical and mechanical effort setpoint via MVB; moreover, the Traction System acquires some digital information (wires line TRACTION; NOBRAKE, NO EMERGENCY BRAKE, NO SAFETY BRAKE) directly from the manipulator and perform consistency checks to detect faults.
As a general rule, braking request always override any traction request; in case of inconsistency, a specific message is recorded.

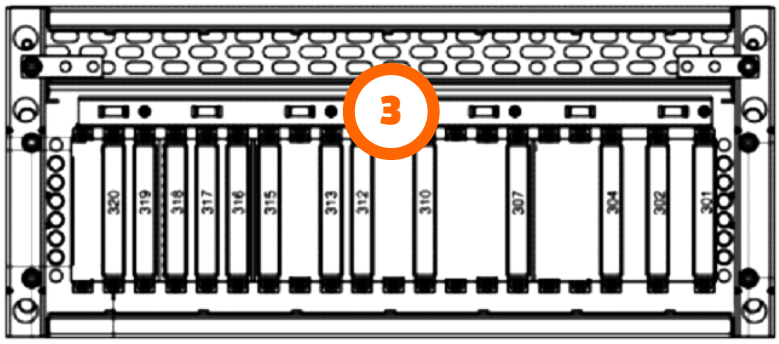
Here below the involved messages.

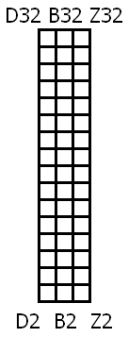
TrainTracerCode		Stack	Text message
xx-27-81		Message	Elec effort incoherence MVB - trainwires
xx-27-92		Message	Cut traction due to mech brake eff req

5.23.2. Involved LRUs

5.23.2.1.TBCU



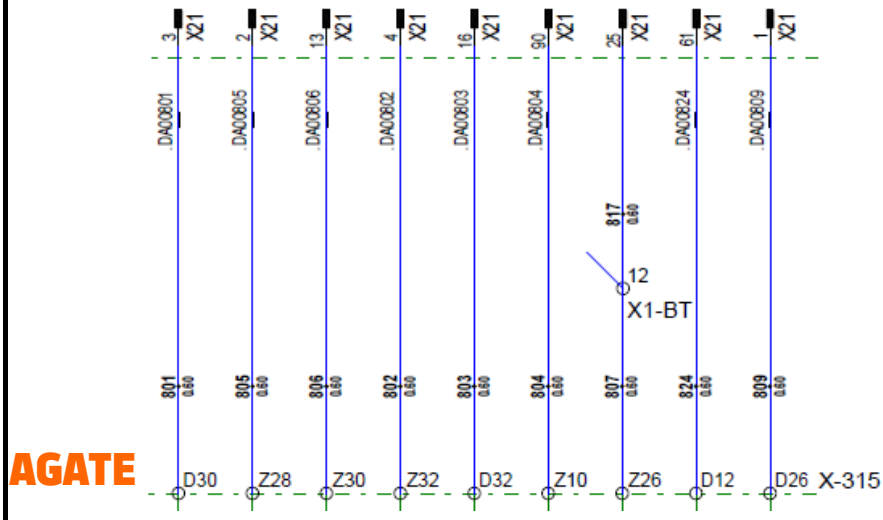




POS	Description	
1	AGATE	**AC3mini**
2	BT connector	**X21**
3	AGATE backplane layout	

5.23.2.2.TBCU LV Scheme

Name	Description	notes	X21
NO_SB	Safety Brake command	Active low (open circuit to SB)	1
L_TRACTION	Traction command	Active high	3
L_NOBRAKE	Service brake command	Active low (open circuit to brake)	13
L_NOEMBR	Emergency brake command	Active low (open circuit to brake)	25



5.23.3. Verifications

1 ***CHECK*** the cabling between the rack and the X21 connector removing the Agate
VERIFY that electrical connections are good

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the Traction System starts without faults

5.24. MVB related faults

5.24.1. Description

All the traction converters installed on vehicle roof are identical, and takes the unique MVB address by specific cable configuration. In case of erroneus configuration (i.e. due to a broken connector or Agate internal fault), the traction converter lock itself in order to avoid unexpected behaviors due to the errors in the

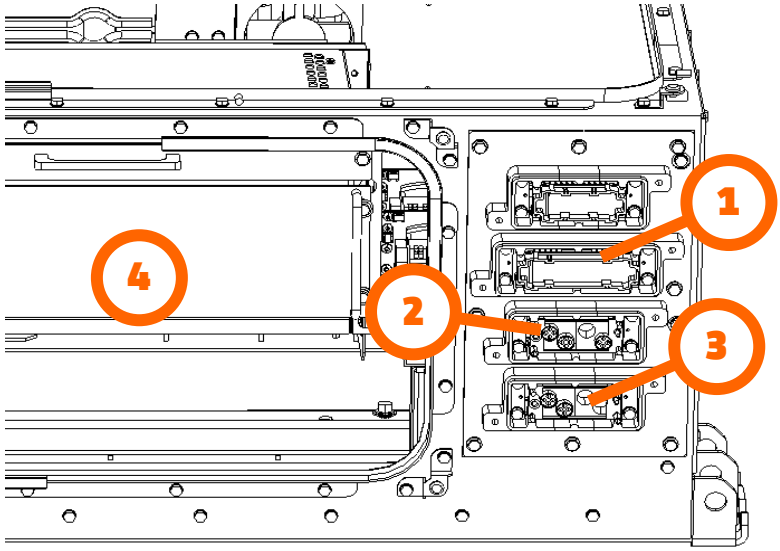
Instead, in case of trouble in the MVB communication after initialization (monitored using a life signal exchanged with TCMS), for safery reasons the torque setpoint is clamped to zero, and the unexpected event is recorded in the diagnostic memory.

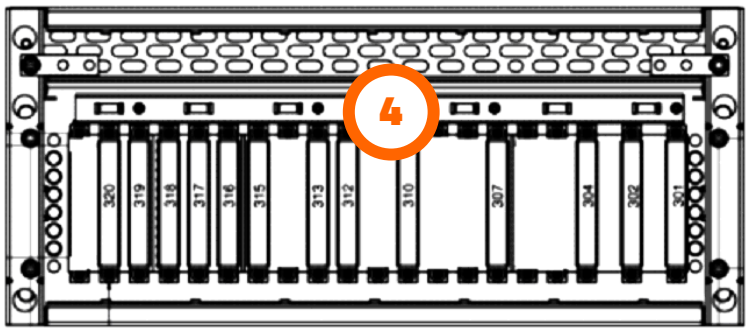
Here below the involved messages.

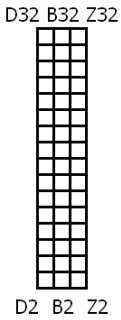
TrainTracerCode		Stack	Text message
xx-27-84		Message	MVB Communication lost
xx-27-85		Message	MVB Communication OK
xx-27-95		Lock	Incorrect TCU Id LOC configuration

5.24.2. Involved LRUs

5.24.2.1.TBCU







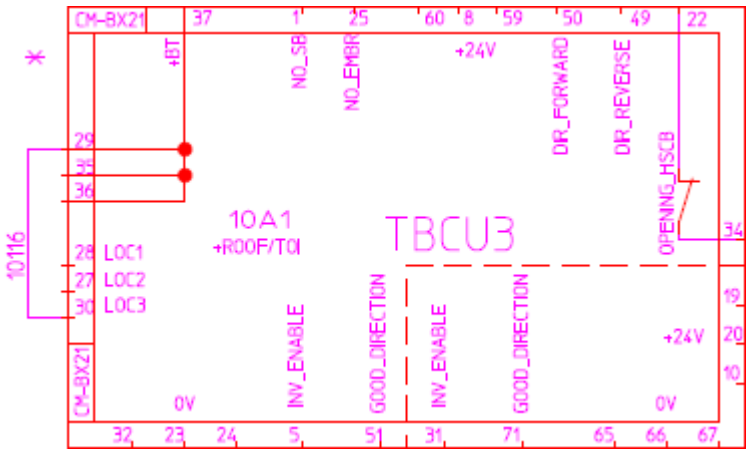
POS	Description	
1	BT connector	**X21**
2	BT connector	**X22**
3	BT connector	**X23**
4	AGATE	**AC3mini**

5.24.2.2.TBCU LV Scheme

Here below the X21 pin-out related to the MVB address configuration.

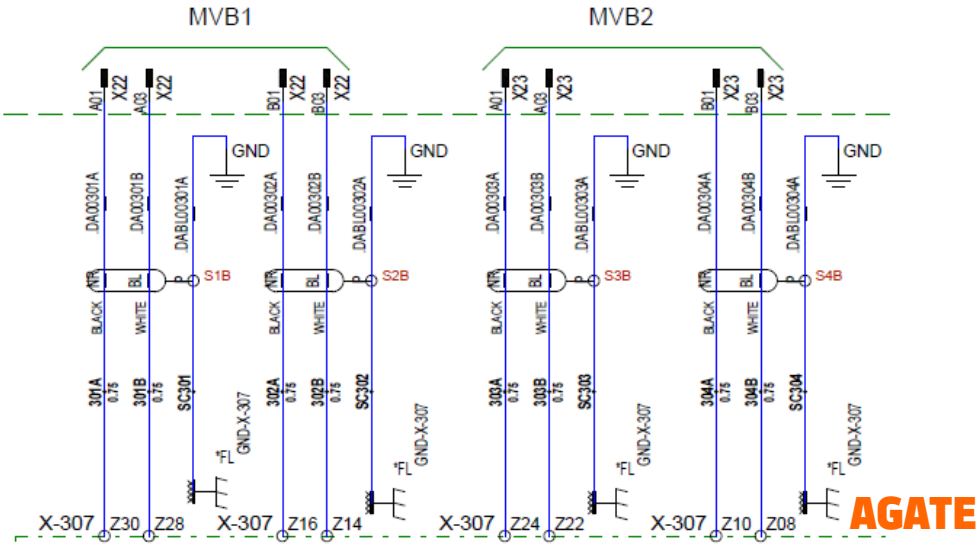
Name	Description	X21
LOC_REF_IN	1 pin to energize LOC_REF pins	37
L_LOC1	Localization input	28
L_LOC2	Localization input	27
L_LOC3	Localization input	30
LOC_REF	3 pins (internally connecter to LOC_REF_IN) for strap configuration	29,35,36

Please consider the drawing below (taken from vehicle LV schemes) to understand the way to configure each Traction Converter; proper battery voltage is provided on pin37; after that, a strap cable (10116) configures the traction converter position on the vehicle.



Name	Description	X22
MVB_A1_DATAN	MVB line A1 – DATA N	A1
MVB_A1_DATAP	MVB line A1 – DATA P	A3
MVB_A2_DATAN	MVB line A2 – DATA N	B1
MVB_A2_DATAP	MVB line A2 – DATA P	B3

Name	Description	X22
MVB_B1_DATAN	MVB line B1 – DATA N	A1
MVB_B1_DATAP	MVB line B1 – DATA P	A3
MVB_B2_DATAN	MVB line B2 – DATA N	B1
MVB_B2_DATAP	MVB line B2 – DATA P	B3



5.24.3. Verifications

In case of **Incorrect TCU Id LOC configuration** do the following steps :

1 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that the Traction System starts without faults

2 ***CHECK*** the cabling between the rack and the X21 connector removing the Agate
VERIFY that electrical connections are good

3 ***CHECK*** the strap cable on the external X21 connector (vehicle side) and the battery voltage on X21-37
VERIFY that electrical connections are good

In case of **MVB Communication lost** do the following steps :

1 ***CHECK*** the cabling between the rack and the X22 / X23 connector removing the Agate
VERIFY that electrical connections are good

2 ***REPLACE*** **AC3mini**, downloading the correct Traction SW version
VERIFY that these specific faults are no more recorded while performing a dynamic test